November 2004

GRAY SEAL (*Halichoerus grypus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The gray seal is found on both sides of the North Atlantic, with three major populations: eastern Canada, northwestern Europe and the Baltic Sea (Katona et al. 1993). The western North Atlantic population occurs from New England to Labrador and is centered in the Sable Island region of Nova Scotia (Mansfield 1966; Katona et al. 1993; Davies 1957; Lesage and Hammill 2001). This stock is separated by geography, differences in the breeding season, and mitochondrial DNA variation from the eastern Atlantic stock (Bonner 1981; Boskovic et al. 1996; Lesage and Hammill 2001). There are two breeding concentrations in eastern Canada; one at Sable Island, and a second that breeds on the pack ice in the Gulf of St. Lawrence (Laviguer and Hammill 1993). Tagging studies indicate that there is little intermixing between the two breeding groups (Zwanenberg and Bowen 1990) and, for management purposes, they are treated as separate populations (Mohn and Bowen 1996). Small numbers of animals and pupping have been observed on several isolated islands along the Maine coast and in Nantucket-Vineyard Sound, Massachusetts (Katona et al. 1993; Rough 1995; J. R. Gilbert, pers. comm., University of Maine, Orono, ME). In the late 1990's, a year-round breeding population of approximately 400+ animals was documented on outer Cape Cod and Muskeget Island (D. Murley, pers. comm., Mass. Audubon Society, Wellfleet, MA). In December 2001, NMFS initiated aerial surveys to monitor gray seal pup production on Muskeget Island and at the Monomoy National Wildlife Refuge (NWR; S. Wood, pers. comm., University of Massachusetts, Boston, MA). Gilbert (pers. comm.) has also documented resident colonies and pupping in Maine since 1994.

POPULATION SIZE

Current estimates of the total western Atlantic gray seal population are not available; although estimates of portions of the stock are available for select time periods. The Canadian population, inhabiting the Gulf of St. Lawrence and Sable Island, appears to be growing. A 1993 survey estimated the population at 144,000 animals (Anon. 2003, Mohn and Bowen 1996) and a 1997 survey estimated 195,000 (Anon. 2003). While the overall population in increasing, the population at Sable Island is increasing by approximately 13% per year, while the population in the Gulf of St. Lawrence is declining (Bowen *et al*. 2003).

The population in US waters is also increasing. Maine coast-wide surveys conducted during summer (all other surveys were conducted January-May) revealed 597 and 1,731 gray seals in 1993 and 2001, respectively (Gilbert et al. in press). In 2002, the maximum counts of two breeding colonies in Maine, with number of pups in parentheses, were 193 (9) on Seal Island and 74 (31) on Green Island (S. Wood, pers. comm., University of Massachusetts, Boston, MA). Gray seal numbers are increasing in Massachusetts at Muskeget Island off the coast of Nantucket, and at Monomoy Island, off the coast Chatham, Cape Cod. Pup counts on Muskeget have increased from 0 in 1989 to 1,023 in 2002 (Rough 1995, S. Wood, pers. comm., University of Massachusetts, Boston, MA). Gray seal numbers increase in this region in the spring (April-May) when molting occurs. In April-May 1994 a maximum count of 2,010 was obtained for Muskeget Island and Monomoy combined (Rough 1995). In March 1999 a maximum count of 5,611 was obtained in the region south of Maine (between Isles of Shoals, NH and Woods Hole, MA) (Barlas 1999). No gray seals were recorded at haul out sites between Newport, RI and Montauk Pt., NY (Barlas 1999), although, more recently small numbers of gray seals have been recorded in this region (deHart 2002; R. DiGiovanni, pers. comm., Riverhead Foundation, Riverhead, NY). Recently, a small number of gray seals have maintained a winter presence in the Woods Hole region (Vineyard Sound) (deHart 2002).

Table 1. Summary of abundance estimates for the western North Atlantic gray seal. Month, year, and area covered during each abundance survey, resulting abundance estimate (N_{min}) and coefficient of variation (CV).

Month/Year	Area	N_{min}[1]	CV
March 1999	Muskeget Island and Monomoy, MA	5,611	none reported
May 2001	Maine coast	1,731	none reported

[1] These counts pertain to animals seen in U.S. waters, and the stock relationship to animals in Canadian waters is unknown.

Minimum Population Estimate

Present data are insufficient to calculate the minimum population estimate for U.S. waters. It is estimated that there are at least 195,000 gray seals in Canada (Anon. 2003).

Current Population Trend

Gray seal abundance is likely increasing in the U.S. Atlantic Exclusive Economic Zone (EEZ), but the rate of increase is unknown. The population in eastern Canada was greatly reduced by hunting and bounty programs, and in the 1950's the gray seal was considered rare (Lesage and Hammill 2001). Bounty and culling programs also occurred between 1976 and 1983, removing approximately 1,720 animals per year (Anon. 2002). The Sable Island population was less affected and has been increasing for several decades . Pup production on Sable Island, Nova Scotia, has been about 13% per year since 1962 (Stobo and Zwanenberg 1990; Mohn and Bowen 1996); whereas, in the Gulf of St. Lawrence the population appears to be declining, and may have been declining since 1990 (Anon. 2003). Approximately 57% of the western North Atlantic population is from the Sable Island stock. In recent years pupping has been established on Hay Island, off the Cape Breton coast (Lesage and Hammill 2001).

Winter breeding colonies in Maine and on Muskeget Island may provide some measure of gray seal population trends and expansion in distribution. Sightings in New England increased during the 1980's as the gray seal population and range expanded in eastern Canada. Five pups were born at Muskeget in 1988. The number of pups increased to 12 in 1992, 30 in 1993, and 59 in 1994 (Rough 1995). In January 2002, between 883-1,023 pups were counted on Muskeget Island and surrounding shoals (S. Wood, pers. comm., University of Massachusetts, Boston, MA). These observations continue the increasing trend in pup production reported by Rough (1995). NMFS recently initiated a collaborative program with the University of Massachusetts, Boston and University of Maine to monitor gray seal population trends and pup production in New England waters. The change in gray seal counts at Muskeget and Monomoy from 2,010 in 1994 to 5,611 in 1999 represents an annual increase rate of 20.5%, however, it can not be determined what proportion of the increase represents growth or immigration.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. One study estimated an annual or net productivity increase in pup production of 13% on Sable Island (Mohn and Bowen 1996; Bowen *et al*. 2003).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow et al. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.12, the default value for pinnipeds. The recovery factor (F_R) for this stock is 1.0, the value for stocks of unknown status, but is known to be increasing. PBR for the western North Atlantic gray seals in U.S. waters is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 1999-2003, the total estimated human caused mortality and serious injury to gray seals was 274 per year. The average was derived from three components: 1) 141(CV=0.26; Table 2) from the 1999-2003 U.S. observed fishery; 2) 3 from average 1999-2003 stranding mortalities in U.S. waters resulting from power plant entrainments, oil spill, shooting, boat strike, and other sources (NMFS unpublished data), and 3) 130 from average 1999-2003 kill in the Canadian hunt (Anon. 2003, Stenson unpublished data).

Fishery Information

Detailed fishery information is given in Appendix III.

U.S.

Northeast Sink Gillnet

There were 52 gray seal mortalities observed in the Northeast sink gillnet fishery between 1993 and 2003.

Annual estimates of gray seal bycatch in the Northeast sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery was 0 in 1990-1992, 18 in 1993 (1.00), 19 in 1994 (0.95), 117 in 1995 (0.42), 49 in 1996 (0.49), 131 in 1997 (0.50),61 in 1998

(0.98), 155 in 1999 (0.51), 193 in 2000 (.55), 117 in 2001 (.59), 0 in 2002 and 242 (0.47) in 2003, and 0 in 2002 (Table 2). There were 0, 1, 5, 8, and 2 unidentified seals observed during 1998 to 2002, respectively. Since 1997 unidentified seals have not been prorated to a species. This is consistent with the treatment of other unidentified mammals that do not get prorated to a specific species. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1999-2003 was 141 gray seals (CV=0.26) (Table 2). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996).

Mid-Atlantic Coastal Gillnet

No gray seals were taken in observed trips during 1998-2000, and 2003. One gray seal was observed taken during 2001 (Table 2). The gray seal was taken at 44 fathom depth during the month of April off the coast of New Jersey near Hudson Canyon. Observed effort was scattered between Delaware and North Carolina from 1 to 50 miles off the beach. In 2002, 65% of sampling was concentrated in one area and not distributed proportionally across the fishery. Therefore, observed mortality is considered unknown in 2002.

CANADA

An unknown number of gray seals have been taken in Newfoundland and Labrador, Gulf of St. Lawrence, and Bay of Fundy groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, Atlantic Canada cod traps, and in Bay of Fundy herring weirs (Read 1994). In addition to incidental catches, some mortalities (e.g., seals trapped in herring weirs) were the result of direct shooting, and there were culls of about 1,700 animals annually during the 1970's and early 1980's on Sable Island (Anon. 1986).

In 1996, observers recorded 3 gray seals (1 released alive) in Spanish deep-water trawl fishing on the southern edge of the Grand Banks (NAFO Areas 3) (Lens, 1997). Seal bycatches occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 2. Summary of the incidental mortality of gray seal (*Halichoerus grypus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast Sink Gillnet[3]	99-03	301	Obs. Data Weighout, Logbooks	.06, .06, .04, .02, .03	5, 5, 2, 0, 5	155, 193, 117, 0, 242	.51, .55, .59, 0, .47	141 (0.26)
Mid-Atlantic Coastal Gillnet[4]	99-03	Unk [5]	Obs. Data Weighout	.02, .02, .02, .01, .01	0, 0, 1, unk[6], 0	0, 0, 0, unk[6], 0	0, 0, 0, unk[6], 0	0 (0.00)
TOTAL								141 (0.26)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects landings data (Weighout), and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of fishing effort in the Northeast multispecies sink gillnet fishery.

2 The observer coverage for the Northeast sink gillnet fishery is measured in trips. Observer coverage of the mid-Atlantic coastal gillnet fisheries are measured in tons of fish landed.

3 In 1998, 2000, and 2001 respectively, observed mortality on "marine mammal trips" was 3, 3 and 2 animals. In 1997 and 1999 all observed takes were on marine mammal trips. In 1998, 2000 and 2001 there was 1, 2 and 1 mortalities recorded on "fish trips". Only mortalities observed on "marine mammal trips" are used to estimate bycatch. See Bisack (1997) for "trip" type definitions. Since 1998, takes from pingered and non-pingered nets within a marine mammal time/area closure that required pingers, and takes from pingered and non-pingered nets not within a marine mammal time/area closure were pooled. The pooled bycatch rate was weighted by the total number of samples taken from the stratum and used to estimate the mortality. In 1998, 1 take was observed in a net without a pinger that was within a marine mammal closure that required pingers. In 1997, 1999 and 2000, respectively, 12, 2 and 2 takes were observed in nets with pingers. In 2001 no gray seals were observed taken in nets equipped with pingers.

4 The one observed take in the mid-Atlantic gillnet fisheries (2001) was on a "fish trip", therefore no mortality estimate was extrapolated. See Bisack (1997) for "trip" type definitions.

5 Number of vessels is not known.

6 Sixty-five percent of sampling in the mid-Atlantic coastal gillnet by the NEFSC fisheries observer program was concentrated in one area off the coast of Virginia. Because of the low level of sampling that was not distributed proportionately throughout the mid-Atlantic region observed mortality is considered unknown in 2002. The four year average (1999-2001, and 2003) estimated mortality was applied as the best representative estimate.

Other Mortality

Canada: In Canada, gray seals were hunted for several centuries by indigenous people and European settlers in the Gulf of St. Lawrence and along the Nova Scotia eastern shore, and were locally extirpated (Lavigueur and Hammill 1993). By the mid 1900's gray seals were considered to be rare, and in the mid 1960's the population in eastern Canada was estimated to be 5,600 (Mansfield 1966). Since the mid-1960's the population has been increasing. During a bounty and culling program (1967-1983), the average annual removals was 1,720 seals (Anon. 2002). Between 1999-2003 the annual kill of gray seals by hunters was: 1999 (98), 2000 (342), 2001 (76) 2002 (126), and 2003 (6) (Anon. 2003; Stenson unpublished data). The traditional hunt of a few hundred animals is expected to continue off the Magdalen Islands and in other areas, except Sable Island where commercial hunting is not permitted (Anon. 2003).

Canada also issues personal hunting licenses which allows the holder to take 6 grey seals annually (Lesage and Hammill 2001). Hunting is not permitted during the breeding season and some additional seasonal/spatial restrictions are in effect (Lesage and Hammill 2001).

U.S: Gray seals, like harbor seals, were hunted for bounty in New England waters until the late 1960's. This hunt may have severely depleted this stock in U.S. waters (Rough 1995). Other sources of mortality include human interactions, storms, abandonment by the mother, disease, and predation. Mortalities caused by human interactions include boat strikes, fishing gear interactions, power plant entrainment, oil spill/exposure, harassment, and shooting. The Cape Cod stranding network has documented gray seals entangled in netting or plastic debris around the Cape Cod/Nantucket area, and in recent years have made successful disentanglement attempts.

From 1999-2003, 321gray seal strandings were recorded, extending from Maine to North Carolina. Most strandings were in Massachusetts (136), New York (55), and Maine (31). Fifteen (4.6%) of the seals stranded during this five year period showed signs of human interaction as a direct cause of mortality.

The total number of gray seal strandings in 2002 and 2003 are presented in Table 3.

Table 3. Gray seal (*Halichoerus grypus*) reported strandings along the U.S. Atlantic coast (2002-2003).

State	2002	2003	Total
Maine	7	6	13
New Hampshire	0	1	1
Massachusetts	43	64	107
Rhode Island	3	7	10
Connecticut	0	0	0
New York	14	0	0
New Jersey	3	14	0
Delaware	0	1	1
Maryland	0	0	0
Virginia____	0	2	2
North Carolina	1	0	1

STATUS OF STOCK

The status of the gray seal population relative to OSP in U.S. Atlantic EEZ waters is unknown, but the populations appear to be increasing in Canadian and U.S. waters. The species is not listed as threatened or endangered under the Endangered Species Act. Recent data indicate that this population is increasing. The total fishery-related mortality and serious injury for this stock is believed to be very low relative to the population size in Canadian waters and can be considered insignificant and approaching zero mortality and serious injury rate. The level of human-caused mortality and serious injury in the U.S. Atlantic EEZ is unknown, but believed to be very low relative to the total stock size; therefore, this is not a strategic stock.

REFERENCES

Anon. 2003. Atlantic seal hunt: 2003-2005 management plan. Available from Canadian Department of Fisheries and Oceans, Ottawa, Ontario, Canada, K1A 0E6, Fisheries Resource Management - Atlantic. 34 pp.

Anon. 2002. Atlantic seal hunt: 2002 management plan. Available from Canadian Department of Fisheries and Oceans, Ottawa, Ontario, Canada, K1A 0E6, Fisheries Resource Management – Atlantic. 39 pp.

Anon. 1986. Seals and sealing in Canada. Rep. of the Royal Commission on Seals and Sealing, Vol. 1, 65 pp. Available from Canadian Government Publishing Centre, Ottawa, Canada.

Barlas, M. E. 1999. The distribution and abundance of harbor seals (*Phoca vitulina concolor*) and gray seals (*Halichoerus grypus*) in southern New England, winter 1998- summer 1999. MA Thesis, Boston University, Graduate School of Arts and Sciences., Boston, MA. 52 pp.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K. D. 1997. Harbor porpoise bycatch estimates in the New England multispecies sink gillnet fishery: 1994 and 1995. *Rep. int Whal. Commn.* 47:705-14.

Bonner, W. N. 1981. Grey seal *Halichoerus grypus Fabricus*, 1791. Pp. 111-144 *in:* S. H. Ridgway and R. J. Harrison (eds), Handbook of marine mammals, Vol. 2: Seals. *Academic Press*, London, 359 pp.

Boskovic, R., K. M. Kovacs, M. O. Hammill, and B. N. White. 1996. Geographic distribution of mitochondrial DNA haplotypes in grey seals (*Halichoerus grypus*). *Can. J. Zool.* 74: 1787-1796.

Bowen, W.D., J. McMillan, and R. Mohn. 2003. Sustained exponential population growth of grey seals at Sable Island, Nova Scotia. *ICES J. Mar. Sci.* 60: 1265-1274.

Davies, J. L. 1957. The geography of the gray seal. *J. Mamm*. 38: 297-310.

deHart, P. A. P. 2002. The distribution and abundance of harbor seals (*Phoca vitulina concolor*) in the Woods Hole region. MA Thesis, Boston University, Graduate School of Arts and Sciences., Boston, MA. 88 pp.

Gilbert, J. R., G. T. Waring, K. M. Wynne, and N. Guldager, in press. Changes in abundance and distribution of harbor seals in Maine, 1981-2001.

Katona, S. K., V. Rough and D. T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. *Smithsonian Institution Press*, Washington, DC. 316 pp.

Laviguer, L. and M. O. Hammill. 1993. Distribution and seasonal movements of grey seals, *Halichoerus grypus*, born in the Gulf of St. Lawrence and eastern Nova Scotia shore. *Can. Field-Nat*. 107: 329-340.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES C.M.* 8/Q. 10 pp.

Lesage, V. and M. O. Hammill. 2001. The status of the grey seal, *Halichoerus grypus*, in the Northwest Atlantic. *Can. Field-Nat*. 115(4): 653-662.

Mansfield, A.W. 1966. The grey seal in eastern Canadian waters. *Can. Audubon Mag*. 28:161-166.

Mohn, R. and W. D. Bowen. 1996. Grey seal predation on the eastern Scotian Shelf: Modeling the impact on Atlantic cod. *Can. J. Aquat. Sci.* 53:2722-2738.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int Whal. Commn.* Special Issue 15: 133-147.

Rough, V. 1995. Gray seals in Nantucket Sound, Massachusetts, winter and spring, 1994. Final report to Marine Mammal Commission, Contract T10155615, 28 pp. NTIS Pub. PB95-191391.

Stobo, W. T. and K. C. T. Zwanenburg. 1990. Grey seal (*Halichoerus grypus*) pup production on Sable Island and estimates of recent production in the northwest Atlantic. Pp. 171-184 *in:* W. D. Bowen (ed), Population biology of sealworm (*Pseudoterranova decipiens*) in relation to its intermediate and seal hosts. *Can. Bull. Fish. and Aq. Sci.* 222.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Zwanenberg, K.C.T. and W.D. Bowen. 1990. Population trends of the grey seal (*Halichoerus grypus*) in eastern Canada. Pp. 185-197 *in*: W.D. Bowen (ed.), Population Biology of Sealworm (*Pseudoterranova decipiens*) in Relation to its Intermediate and Seal Hosts. *Can. Bull. Fish. and Aq. Sci*. 222.

November 2004

HARBOR SEAL (*Phoca vitulina*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The harbor seal is found in all nearshore waters of the Atlantic Ocean and adjoining seas above about 30^0N (Katona et al. 1993). In the western North Atlantic, they are distributed from the eastern Canadian Arctic and Greenland south to southern New England and New York, and occasionally to the Carolinas (Mansfield 1967; Boulva and McLaren *1979*; Katona *et al.* 1993; Gilbert and Guldager 1998; Baird 2001). Stanley *et al.* (1996) examined worldwide patterns in harbor seal mitochondrial DNA, which indicate that western and eastern North Atlantic harbor seal populations are highly differentiated. Further, they suggested that harbor seal females are only regionally philopatric, thus population or management units are on the scale of a few hundred kilometers. Although the stock structure of the western North Atlantic population is unknown, it is thought that harbor seals found along the eastern U.S. and Canadian coasts represent one population (Temte *et al.* 1991). In U.S. waters, breeding and pupping normally occur in waters north of the New Hampshire/Maine border, although breeding occurred as far south as Cape Cod in the early part of the twentieth century (Temte *et al.* 1991; Katona *et al.* 1993).

Harbor seals are year-round inhabitants of the coastal waters of eastern Canada and Maine (Katona *et al.* 1993), and occur seasonally along the southern New England and New York coasts from September through late May (Schneider and Payne 1983). In recent years, their seasonal interval along the southern New England to New Jersey coasts has increased (Barlas 1999; Hoover *et al.* 1999; Slocum *et al.* 1999; deHart 2002). Scattered sightings and strandings have been recorded as far south as Florida (NMFS unpublished data). A general southward movement from the Bay of Fundy to southern New England waters occurs in autumn and early winter (Rosenfeld *et al.* 1988; Whitman and Payne 1990; Barlas 1999; Jacobs and Terhune 2000). A northward movement from southern New England to Maine and eastern Canada occurs prior to the pupping season, which takes place from mid-May through June along the Maine Coast (Richardson 1976; Wilson 1978; Whitman and Payne 1990; Kenney 1994; deHart 2002). No pupping areas have been identified in southern New England (Payne and Schneider 1984; Barlas 1999). More recent information suggests that pupping is occurring at high-use haulout sites off Manomet, Massachusetts (B. Rubinstein, pers. comm., New England Aquarium). The overall geographic range throughout coastal New England has not changed significantly during the last century (Payne and Selzer 1989).

Prior to spring 2001 live capture and radio tagging of adult harbor seals, including a pregnant female, in Chatham, Massachusetts (NMFS unpub. data), it was believed that the majority of seals moving into southern New England and mid-Atlantic waters are subadults and juveniles (Whitman and Payne 1990; Katona *et al.* 1993; Slocum *et al.* 1999).

POPULATION SIZE

Since passage of the MMPA in 1972, the observed count of seals along the New England coast has been increasing. Five coast-wide aerial surveys along the Maine coast have been conducted in May/June during pupping. Uncorrected counts, with number of pups in parentheses, between 1981 and 2001 were 10,540 (676) in 1981, 12,940 (1,713) in 1986, 29,530 (4,250) in 1993, 30,617 (5,272) in 1997 and 38,011 (9,278) in 2001 (Table1; Gilbert and Stein 1981; Gilbert and Wynne 1983, 1984; Kenney 1994; Gilbert and Guldager 1998; Gilbert *et al.* in press). As recommended in the GAMMS Workshop Report (Wade and Anglis 1997), estimates older than eight years are deemed unreliable, and therefore should not be used for PBR determinations. The 2001 survey, conducted in May/June, included replicate surveys and radio tagged seals to obtain a correction factor for animals not hauled out. The corrected estimate for 2001 is 99,340 (23,723). Prior to 2001, the numbers are considered to be a minimum abundance estimate because they are uncorrected for animals in the water or outside the survey area. In addition, the surveys conducted in 1981 and 1986 were conducted in late June, after peak pupping. Therefore the numbers are underestimates and are not used in determining population trend (Gilbert *et al.* in press). The 2001 observed count of 38,011 is 28.7% greater than the 1997 count. Increased abundance of seals in the northeast region has also been documented during aerial and boat surveys of overwintering haul-out sites from the Maine/New Hampshire border to eastern Long Island and New Jersey (Payne and Selzer 1989; Rough 1995; Barlas 1999; Hoover *et al.* 1999; Slocum *et al.* 1999; deHart 2002).

Canadian scientists counted 3,500 harbor seals during an August 1992 aerial survey in the Bay of Fundy (Stobo and Fowler 1994), but noted that the survey was not designed to obtain a population estimate. The Sable Island population was the largest in eastern Canada in the late 1980's, however, recently the number has drastically declined (Baird 2001). Similarly, pup production declined on Sable Island from 600 in 1989 to 30 in 1997 (Baird

2001). Possible reasons for this decline may be increased use of the island by gray seals and increased predation by sharks (Stobo and Lucas 2000).

Table 1. Summary of abundance estimates for the western Atlantic harbor seal. Month, year, and area covered during each abundance survey, resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best} [1]	CV
May/June 1997	Maine coast	30,990 (NA)[2]	None reported
May/June 2001	Maine coast	99,340 (21,732)[3]	CV=.097

[1] Pup counts are in brackets
[2] CV calculations for prior estimates are not available
[3] Corrected estimate based on uncorrected count of 38,011 (9,278)

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for harbor seals is 99,340 (CV=.097). The minimum population estimate is 91,546 (CV=.097) based on corrected total counts along the Maine coast in 2001.

Current Population Trend

The average increase in uncorrected counts over the 1993-2001 survey period (e.g., 1993, 1997 and 2001) has been 3.2% (Gilbert *et al.* in press). This increase is lower than the increase estimated in previous years because the data from 1981 and 1986 surveys are no longer used.

Possible factors contributing to harbor seal population increase include MMPA protection, fishery management regulations (e.g., closed areas, fishing effort reduction) designed to rebuild groundfish stocks, and posible increased food availability

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this population. Based on uncorrected haulout counts over the 1993 to 2001 survey period, the harbor seal population is growing at approximately 3.2% (Gilbert *et al.*, in press). However, a population grows at the maximum growth rate (R_{MAX}) only when it is at a very low level; thus the 3.2% growth rate is not considered to be a reliable estimate of (R_{MAX}). For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate (½ of 12%), and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 91,546. The recovery factor (F_R) for this stock is 1.0, the value for stocks of unknown status, but known to be increasing. PBR for U.S. waters is 5,493.

ANNUAL HUMAN-CAUSED MORTALITY

For the period 1999-2003, the total human caused mortality and serious injury to harbor seals is estimated to be 1,051 per year. The average is derived from two components: 1) 91,032 (CV=0.17 ; Table 2) from the 1999-2003 observed fishery; and 2) 19 from average 1999-2003 stranding mortalities resulting from boat strikes, power plant entrainments, shooting, and other sources (NMFS unpublished data).

Researchers and fishery observers have documented incidental mortality in several fisheries, particularly within the Gulf of Maine (see below). An unknown level of mortality also occurred in the mariculture industry (i.e., salmon farming), and by deliberate shooting (NMFS unpublished data). However, no data are available to determine whether shooting still takes place.

Fishery Information

Detailed Fishery information is given in Appendix III.

U.S.

Historical: Incidental takes of harbor seals have been recorded in groundfish gillnet, herring purse seine, halibut tub trawl, and lobster fisheries (Gilbert and Wynne, 1985 and 1987). A study conducted by the University of Maine reported a combined average of 22 seals entangled annually by 17 groundfish gillnetters off the coast of Maine (Gilbert and Wynne 1987). All seals were young of the year and were caught from late June through August and in early October. Interviews with a limited number of mackerel gillnetters indicated only one harbor seal entanglement and a negligible loss of fish to seals. Net damage and fish robbing were not reported to be a major economic concern to gillnetters interviewed (Gilbert and Wynne 1987).

Herring purse seiners have reported accidentally entrapping seals off the mid-coast of Maine, but indicated that the seals were rarely drowned before the seine was emptied (Gilbert and Wynne 1985). Capture of seals by halibut tub trawls is rare. One vessel captain indicated that he took one or two seals a year. These seals were all hooked through the skin and released alive, indicating they were snagged as they followed baited hooks. Infrequent reports suggest seals may rob bait off longlines, although this loss is considered negligible (Gilbert and Wynne 1985).

Incidental takes in lobster traps in inshore waters off Maine are reportedly rare. Captures of approximately two seal pups per port per year were recorded by mid-coastal lobstermen off Maine (Gilbert and Wynne 1985). Seals have been reported to rob bait from inshore lobster traps, especially in the spring, when fresh bait is used. These incidents may involve only a few individual animals. Lobstermen claim that seals consume shedding lobsters, but there are no data to support this.Current: Commercial fisheries observed for harbor seal bycatch are the Northeast Sink Gillnet, Mid-Atlantic Coastal Gillnet, and North Atlantic Bottom Trawl fisheries.

Northeast Sink Gillnet:

The fishery has been observed in the Gulf of Maine and in southern New England (Williams 1999; NMFS unpublished data). There were 000 harbor seal mortalities observed in the Northeast sink gillnet fishery between 1990 and 2003, excluding three animals taken in the 1994 pinger experiment (NMFS unpublished data). Williams (1999) aged 261 harbor seals caught in this fishery from 1991 to 1997, and 93% were juveniles (e.g. less than four years old). Annual estimates of harbor seal bycatch in the Northeast sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1999-2003 were 332 in 1998 (0.33), 1,446 in 1999 (0.34), 917 (0.43) in 2000, 1,471 (.38) in 2001,787 (.32) in 2002, and 542 (0.28) in 2003 (Table 2). There were 1, 5, 8, 2, and 2 unidentified seals observed during 1999-2003, respectively. Since 1997, unidentified seals have not been prorated to a species. This is consistent with the treatment of other unidentified mammals that do not get prorated to a specific species. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1999-2003 was 1,032 harbor seals (CV=0.17) (Table 2). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch occurred in the Midcoast closure region (2) and east of Cape Cod (1) between January and April. Between May and August 6 animals were caught off Massachusetts and New Hampshire, and between September and December 4 were caught in the Midcoast closure area.

Mid-Atlantic Coastal Gillnet

No harbor seals were taken in observed trips during 1993-1997, and 1999-2003 . Two harbor seals were observed taken in 1998. Observed effort was concentrated off New Jersey and scattered between Delaware and North Carolina from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 in 1995-1997 and 1999-2003 and 11 in 1998 (0.77). Average annual estimated fishery-related mortality attributable to this fishery during 1999-2003 was zero harbor seals. In 2002, 65% of observer coverage was concentrated in one area and not distributed proportionally across the fishery. Therefore observed mortality is considered unknown in 2002.

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. No mortalities were observed between 1991-2001; 4 mortalities were observed in 2002 (Table 2). Observer coverage, expressed as number of trips, was < 1% from 1998 to 2001, and 2% in 2002 (Table 2). The estimated annual fishery-related mortality and serious injury attributable to this fishery are currently being determined.

CANADA

Currently, scant data are available on bycatch in Atlantic Canada fisheries due to a lack of observer programs (Baird 2001). An unknown number of harbor seals have been taken in Newfoundland, Labrador, Gulf of St. Lawrence and Bay of Fundy groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, Atlantic Canada cod traps, and in Bay of Fundy herring weirs (Read 1994). Furthermore, some of these mortalities (e.g., seals trapped in herring weirs) are the result of direct shooting.

In 1996, observers recorded 7 harbor seals (one released alive) in Spanish deep-water trawl fishing on the southern edge of the Grand Banks (NAFO Areas 3) (Lens, 1997). Seal bycatches occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 2. Summary of the incidental mortality of harbor seals (*Phoca vitulina*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast [3] Sink Gillnet	99-03	301	Obs. Data Weighout, Logbooks	.06, .06, .04, .02, .03	49, 26, 32, 12, 21	1446, 917, 1471, 787, 542	.34, .43, .38, .32, .28	1032 (0.17)
mid-Atlantic Coastal Sink Gillnet	99-03	Unk[4]	Obs. Data Weighout	.02, .02, .02, .01, .01	0, 0, 0, unk[5], 0	0, 0, 0, unk[5], 0	0, 0, 0, unk[5] , 0	[5] 0 (0)
North Atlantic Bottom Trawl	99-03	TBD	Obs. Data Weighout	.003, .004, .004, .021, tbd	0, 0, 0, 4,	0, 0, 0, TBD[6], 0	0, 0, 0, TBD[6], 0	TBD[6]
TOTAL								1032 (0.17)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects landings data (Weighout), and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of fishing effort in the Northeast sink gillnet fishery.

2 The effort for the Northeast sink gillnet fishery is measured in trips. Observer coverage of the mid-Atlantic coastal gillnet fishery is measured in tons of fish landed.

3 In 1997, 1998, 1999, 2000 and 2001 respectively, observed mortality on "marine mammal trips" was 43, 13, 45, 26 and 27 animals. Only these mortalities were used to estimate total harbor seal bycatch. See Bisack (1997) for "trip" type definitions. From 1997 to 2001, respectively, 1, 2, 4, 3 and 5 harbor seals were observed on dedicated fish sampling trips. From 1997 to 2001, respectively, 14, 1, 5, 8 and 10 harbor seals were observed taken in nets equipped with pingers. Since 1998, takes from non-pingered nets within a marine mammal time/area closure that required pingers, and takes from pingered nets not within a marine mammal time/area closure that did not required pingers were pooled with the takes from nets with and without pingers from the same stratum. The pooled bycatch rate was weighted by the total number of samples taken from the stratum and used to estimate the mortality.

4 Number of vessels is not known.

5 Sixty-five percent of sampling in the mid-Atlantic coastal gillnet by the NEFSC fisheries observer program was concentrated in one area off the coast of virginia. Because of the low level of sampling that was not distributed proportionately thrroughout the mid-Atlantic region observed mortality is considered unknown in 2002. The four year average (1999-2001, and 2003) estimated mortality was applied as the best representative estimate.

6 Estimating mortality attributed to the North Atlantic bottom trawl fishery is in progess.

Other Mortality

Historically, harbor seals were bounty hunted in New England waters, which may have caused a severe decline of this stock in U.S. waters (Katona *et al.* 1993). Bounty hunting ended in the mid-1960's.

Currently, aquaculture operations in eastern Canada are licensed to shoot nuisance seals, but the number of seals killed is unknown (Baird 2001). Other sources of harbor seal mortality include human interactions, storms, abandonment by the mother, disease, and predation (Katona *et al.* 1993; Jacobs and Terhune 2000; NMFS unpublished data). Mortalities caused by human interactions include boat strikes, fishing gear interactions, power plant entrainment, oil spill/exposure, harassment, and shooting.

Small numbers of harbor seals strand each year throughout their migratory range. Stranding data provide insight into some of these sources of mortality. From 1999-2003, 1432 harbor seal strandings were reported (150 in 1999, 219 in 2000, 246 in 2001, 337 in 2002, and 479 in 2003) in all states between Maine and North Carolina (Table 3; NMFS unpublished data). Ninety-nine (6.9%) of the seals stranded during this five year period showed signs of human interaction as a direct cause of mortality.

Table 3. Harbor seal (*Phoca vitulina*) reported strandings along the U.S. Atlantic coast (2002-2003).

State	2002	2003	Total
Maine	183	259	442
New Hampshire	3	15	18
Massachusetts	108	109	217
Rhode Island	4	12	16
Connecticut	0	1	1
New York	18	20	38
New Jersey	15	30	45
Delaware	0	2	2
Maryland	0	2	2
Virginia	3	6	9
North Carolina	3	23	26

Stobo and Lucas (2000) have documented shark predation as an important source of natural mortality at Sable Island, Nova Scotia. They suggest that shark-inflicted mortality in pups, as a proportion of total production, was less than 10% in 1980-1993, approximately 25% in 1994-1995, and increased to 45% in 1996. Also, shark predation on adults was selective towards mature females. They suggest that the combined predation mortality is likely impacting the Sable Island population growth, and may be contributing to the observed population decline.

STATUS OF STOCK

The status of harbor seals, relative to OSP, in the U.S. Atlantic EEZ is unknown, but the population is increasing. The species is not listed as threatened or endangered under the Endangered Species Act. Gilbert *et al.* (in press) estimated a 3.2% annual rate of increase of this stock in Maine coastal waters based on 1993, 1997, and 2001 surveys conducted along the Maine coast. The population is increasing despite the known fishery-related and other human sources of mortality. Total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be approaching zero mortality and serious injury rate. This is not a strategic stock because fishery-related mortality and serious injury does not exceed PBR.

REFERENCES

Baird, R. W. 2001. Status of harbor seals, *Phoca vitulina*, in Canada. *Can. Field-Nat*. 115:663-675.

Barlas, M. E. 1999. The distribution and abundance of harbor seals (*Phoca vitulina concolor*) and gray seals (*Halichoerus grypus*) in southern New England, winter 1998- summer 1999. MA Thesis, Boston University, Graduate School of Arts and Sciences., Boston, MA. 52 pp.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K. D. 1997. Harbor porpoise bycatch estimates in the New England multispecies sink gillnet fishery: 1994 and 1995. *Rep. int Whal. Commn.* 47:705-14.

Boulva, J. and I. A. McLaren. 1979. Biology of the harbor seal, *Phoca vitulina*, in eastern Canada. *Bull. Fish. Res. Bd. Can.* 200:1-24.

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise bycatch in the Gulf of Maine sink gillnet fishery, 1990-93. *Rep. int Whal. Commn.* 46:567-574.

deHart, P. A. P. 2002. The distribution and abundance of harbor seals (*Phoca vitulina concolor*) in the Woods Hole region. MA Thesis, Boston University, Graduate School of Arts and Sciences. Boston, MA, 88 pp.

Gilbert, J. R., G. T. Waring, K. M. Wynne, N. Guldager, Changes in abundance and distribution of harbor seals in Maine, 1981-2001. *Mar. Mammal Sci*, in press.

Gilbert, J. R. and J. L. Stein. 1981. Harbor seal populations and marine mammal fisheries interactions, 1981. Annual report, Contract NA-80-FA-C-00029, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 35 pp.

Gilbert, J. R. and K. M. Wynne. 1983. Harbor seal populations and marine mammal fisheries interactions, 1982. Second annual report, Contract NA-80-FA-C-00029, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 43 pp.

Gilbert, J. R. and K. M. Wynne. 1984. Harbor seal populations and marine mammal fisheries interactions, 1983. Third annual report, Contract NA-80-FA-C-00029, to NMFS, Northeast Fisheries Science Center, 166 Water St, Woods Hole, MA. 52 pp.

Gilbert, J. R. and K. M. Wynne. 1985. Harbor seal populations and fisheries interactions with marine mammals in New England, 1984. Interim Rep., NOAA NA-84-EAC-00070, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 15 pp.

Gilbert, J. R. and K. M. Wynne. 1987. Marine mammal interactions with New England gillnet fisheries. Final Report, Contract No. NA-84-EAC-00070, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 21 pp.

Gilbert, J. R. and N. Guldager. 1998. Status of harbor and gray seal populations in northern New England. Final Report under NMFS/NER Cooperative Agreement 14-16-009-1557, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 13 pp.

Hoover, K., S. Sadove and P. Forestell. 1999. Trends of harbor seal, *Phoca vitulina*, abundance from aerial surveys in New York waters: 1985-1999. Proceedings of the 13th Biennial Conference on the Biology of Marine , Wailea, Hawaii, Nov. 28 - Dec. 3, 1999. (Abstract).

Jacobs, S. R. and J. M. Terhune. 2000. Harbor seal (*Phoca vitulina*) numbers along the New Brunswick coast of the Bay of Fundy in autumn in relation to aquaculture. *Northeastern Naturalist* 7(3): 289-296.

Katona, S. K., V. Rough and D. T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. *Smithsonian Institution Press*: Washington, DC, 316 pp.

Kenney, M. K. 1994. Harbor seal population trends and habitat use in Maine. M.S. Thesis. University of Maine, Orono, ME. 55 pp.

Kenney, M. K. and J. R. Gilbert. 1994. Increase in harbor and gray seal populations in Maine. Final Report, Contract No. 50-EANF-2-00064, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 19 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES C.M. 8/Q. 10 pp.*

Mansfield, A. W. 1967. Distribution of the harbor seal, *Phoca vitulina* Linnaeus, in Canadian Arctic waters. *J. Mamm*. 48(2): 249-257.

Payne. P. M. and D. C. Schneider. 1984. Yearly changes in abundance of harbor seals, *Phoca vitulina*, at a winter haul-out site in Massachusetts. *Fish. Bull., U.S.* 82: 440-442.

Payne, P. M. and L. A. Selzer. 1989. The distribution, abundance and selected prey of the harbor seal, *Phoca vitulina concolor*, in southern New England. *Mar. Mammal Sci.* 5(2): 173-192.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int Whal. Commn*. Special Issue 15: 133-147.

Richardson, D. T. 1976. Assessment of harbor and gray seal populations in Maine 1974-1975. Final report, contract No. MM4AC009, Marine Mammal Commission., Washington, DC, 46 pp.

Rosenfeld M., M. George and J. M. Terhune. 1988. Evidence of autumnal harbour seal, *Phoca vitulina*, movement from Canada to the United States. *Can. Field-Nat.* 102(3): 527-529.

Rough, V. 1995. Gray seals in Nantucket Sound, Massachusetts, winter and spring, 1994. Final report to Marine Mammal Commission, Contract T10155615, 28 pp. NTIS Pub. PB95-191391.

Schneider, D. C. and P. M. Payne. 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. *J. Mamm.* 64(3): 518-520.

Slocum, C.J., R. Schoelkopf, S. Tulevech, M. Stevens, S. Evert and M. Moyer. 1999. Seal populations wintering in New Jersey (USA) have increased in abundance and diversity. Proceedings of the 13th Biennial Conference on the Biology of Marine Mammals, Wailea, Hawaii, Nov. 28 - Dec. 3, 1999. (Abstract).

Stanley, H. F., S. Casey, J. M. Carnahan, S. Goodman, J. Harwood, and R. K. Wayne. 1996. Worldwide patterns of mitochondrial DNA differentiation in the harbor seal (*Phoca vitulina*). *Mol. Biol. Evol*. 13: 368-382.

Stobo, W. T. and G. M. Fowler. 1994. Aerial surveys of seals in the Bay of Fundy and off southwest Nova Scotia. *Can. Tech. Rep. Fish. Aquat. Sci.* 1943:57 pp.

Stobo, W. T. and Z. Lucas. 2000. Shark-inflicted mortality on a population of harbour seals (*Phoca vitulina*) at Sable Island, Nova Scotia. *J. Zool. Lond*. 252: 405-414.

Temte, J. L., M. A. Bigg and O. Wiig. 1991. Clines revisited: the timing of pupping in the harbour seal (*Phoca vitulina*). *J. Zool. Lond*. 224: 617-632.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Whitman, A. A. and P. M. Payne. 1990. Age of harbour seals, *Phoca vitulina concolor*, wintering in southern New England. *Can. Field-Nat.* 104(4): 579-582.

Williams, A. S. 1999. Prey selection by harbor seals in relation to fish taken by the Gulf of Maine sink gillnet fishery. M.S. Thesis University of Maine, Orono, ME. 62 pp.

Wilson, S. C. 1978. Social organization and behavior of harbor seals, *Phoca concolor*, in Maine. Final Report contract MM6ACO13, GPO-PB-280-188, Marine Mammal Commission, Washington, DC, 36 pp.

HARP SEAL (*Phoca groenlandica*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The harp seal occurs throughout much of the North Atlantic and Arctic Oceans (Ronald and Healey 1981; Lavigne and Kovacs 1988); however, in recent years, numbers of sightings and strandings have been increasing off the east coast of the United States from Maine to New Jersey (Katona *et al.* 1993; Stevick and Fernald 1998; B. Rubinstein, pers. comm., New England Aquarium; McAlpine 1999; Lacoste and Stenson 2000). These extralimital appearances usually occur in January-May (Harris *et al.* 2002), when the western North Atlantic stock of harp seals is at its most southern point of migration. Concomitantly, a southward shift in winter distribution off Newfoundland was observed during the mid-1990s, which was attributed to abnormal environmental conditions (Lacoste and Stenson 2000). The world's harp seal population is divided into three separate stocks, each identified with a specific breeding site (Bonner 1990; Lavigne and Kovacs 1988). The largest stock is located in the western North Atlantic off eastern Canada and is divided into two breeding herds which breed on the pack ice. The Front herd breeds off the coast of Newfoundland and Labrador, and the Gulf herd breeds near the Magdalen Islands in the middle of the Gulf of St. Lawrence (Sergeant 1965; Lavigne and Kovacs 1988). The second stock breeds in the White Sea off the coast of the Soviet Union, and the third stock breeds on the West Ice off eastern Greenland (Lavigne and Kovacs 1988). Harp seals are highly migratory (Sergeant 1965; Stenson and Sjare 1997). Breeding occurs at different times for each stock between mid-February and April . Adults then assemble north of their whelping patches to undergo the annual molt. The migration then continues north to Arctic summer feeding grounds. In late September, after a summer of feeding, nearly all adults and some of the immature animals migrate southward along the Labrador coast, usually reaching the entrance to the Gulf of St. Lawrence by early winter. There they split into two groups, one moving into the Gulf and the other remaining off the coast of Newfoundland.

The extreme southern limit of the harp seal's habitat extends into the U.S. Atlantic Exclusive Economic Zone (EEZ) during winter and spring. Support for the increase in numbers and geographic distribution of harp seals in New England to mid-Atlantic waters is based primarily on strandings, and secondarily on fishery bycatch (McAlpine and Walker 1990; Rubinstein 1994).

POPULATION SIZE

The total population size of harp seals is unknown; however, three seasonal abundance estimates are available which use a variety of methods including aerial surveys and mark-recapture (Table 1). Generally, these methods include surveying the whelping concentrations and modeling pup production. Harp seal pup production in the 1950's was estimated at 645,000 decreasing to 225,000 by 1970 (Sergeant 1975). Estimates began to increase at that time and have continued to rise, reaching 478,000 in 1979 (Bowen and Sergeant 1983; Bowen and Sergeant 1985), 577,900 in 1990 (Stenson *et al.* 1993), and 998,000 in 1999 (Stenson *et al.* 2000).

Roff and Bowen (1983) developed an estimation model to provide a more precise estimate of total abundance. This technique incorporates recent pregnancy rates and estimates of age-specific hunting mortality (CAFSAC 1992). Shelton *et al.* (1992) applied a harp seal estimation model to the 1990 pup production and obtained an estimate of 3.1 million (range 2.7-3.5 million; Stenson 1993). Using a revised population model, 1994 pup count data, and two assumptions regarding pup mortality rates, Shelton *et al.* (1996) estimated pup production and total population size for the period 1955-1994. The 1994 total population estimate was 4.8 million (95% CI= 4.1-5.5 million) harp seals (Warren *et al.* 1997). The 1999 population estimate was 5.2 million (95% CI=4.0-6.4 million) harp seals (Healey and Stenson 2000) (Table 1).

Table 1. Summary of abundance estimates (pups and total) for western North Atlantic harp seals. Year and area covered during each abundance survey, resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
1999	Eastern Atlantic Canada - Labrador	998,000 pups	±200,000 (95% CI)
1999	Eastern Atlantic Canada - Labrador	5.2 million	±1,200,000 (95% CI)

Minimum population estimate

Present data are insufficient to calculate the minimum population estimate for U.S. waters. It is estimated there are at least 5.2 million (±1.2 million) harp seals in Canada (Healey and Stenson 2000).

Current population trend

The population appears to be increasing in U.S. waters, judging from the increased number of stranded harp seals, but the magnitude of the suspected increase is unknown. In Canada, since 1996 the population has been stable (5.2 million; ±1.2 million) due to large harvests of young animals in recent years (Healey and Stenson 2000).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. The best data are based on Canadian studies. Recent studies indicate that pup production has increased (Stenson *et al.* 2002, Stenson *et al.* 2003), but the rate of population increase cannot be quantified at this time (Stenson *et al.* 1996). The mean age of sexual maturity was 5.8 yrs in the mid-1950's, declining to 4.6 yrs in the early 1980's and then increasing to 5.6 yrs in the mid-1990's (Sjare *et al.* 1996; Sjare and Stenson 2000).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size in U.S. waters is unknown. The maximum productivity rate is 0.12, the default value for pinnipeds. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) was set at 1.0 because it was believed that harp seals are within OSP. PBR for the western North Atlantic harp seal in U.S. waters is unknown. Applying the formula to the minimum population estimate for Canadian waters results in a "PBR" of 312,000 harp seals. However, Johnston *et al.* (2000) suggests that catch statistics from the Canadian hunt are negatively biased due to under reporting; therefore, an F_R of 0.5 may be appropriate. Using the lower F_R results in a "PBR" of 156,000 harp seals. The Canadian model predicts replacement yields between 522,000 and 541,000 (Healey and Stenson 2000).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 1999-2003, the total estimated annual human caused mortality and serious injury to harp seals was 453,962. Estimated annual human caused mortality in US waters is 41, derived from two components: 1) 36 harp seals (CV=0.53) from the observed U.S. fisheries (Table 2), and 2) 4.6 from average 1999-2003 stranding mortalities resulting from human interactions (NMFS unpublished data). The remaining mortality is derived from five components: 1) 232,915 from to 1999-2003 average commercial catches of northwest Atlantic harp seals by Canada (244,552 in 1999, 91,602 in 2000, 226,493 in 2001, 312,367 in 2002, and 289,512 in 2003) (Hammill and Stenson 2003, Anon. 2003a, Stenson unpublished data); 2) 83,010 from 1999-2002 (2003 unavailable) average Greenland catch (, 97,583 in 1999, 101,941 in 2000, 81,390 in 2001, and- 51,124 in 2002) (Anon. 2003b, Stenson unpublished data), 3) 4,881 average catches in the Canadian Arctic (4,881 in each year) (Hammill and Stenson, 2003), and 4) 18,566 from 1999-2002 (2003 unavailable) average bycatches in the Newfoundland lumpfish fishery (18,443 in 1999, 18,607 in 2000, 18,607 in 2001, and 18,607 in 2002) (Stenson unpublished data), and 5) 119,430 from 1999-2002 (2003 unavailable) average struck and lost animals (animals that are killed but not recovered) (21,748 in 1999, 117,864 in 2000, 109,313 in 2001 and 128,794 in 2002) (Stenson unpublished data). The struck and lost component can be further broken down into struck and lost from the commercial harvest (,20,902 average from 1999 t0 2002 (2003 unavailable): 19,284 in 1999, 11,043 in 2000, 23,042 in 2001, and 30,275 in 2002), and struck and lost from the Canadian Arctic and Greenland harvests (87,890 average from 1999 to 2002; 2003 unavailable): 102,464 in 1999, 106,822 in 2000, 86,271 in 2001, and 56,005 in 2002) (Stenson unpublished data). Struck and lost is calculated for the commercial harvest assuming that the rate is 5% for young of the year, and 50% for animals one year of age and older (Anon 2001, Stenson unpublished data). The Canadian Arctic and Greenland struck and lost rate is calculated assuming the rate is 50% for all age classes (Anon 2001; Stenson unpublished data).

Fishery Information

U.S.

Detailed fishery information is reported in the Appendix III.

Northeast Sink Gillnet:

There were 122 harp seal mortalities observed in the Northeast sink gillnet fishery between 1990 and 2002. Annual estimates of harp seal bycatch in the Northeast sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1999-2003 were: 81 in 1999 (0.78), 24 in 2000 (1.57), 26 in 2001 (1.04), and 0 during 2002-2003 (Table 2) There were 0, 1, 5, 8 and 2 unidentified seals observed during 1998 through 2002, respectively. Since 1997, unidentified seals have not been prorated to a species. This is consistent with the treatment of other unidentified mammals that do not get prorated to a specific species. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1999-2003 was 26 harp seals (CV=0.60). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch occurred principally in winter (January-May) and was mainly in waters between Cape Ann and New Hampshire. One observed winter mortality was in waters south of Cape Cod.

Mid-Atlantic Coastal Gillnet:

No harp seals were taken in observed trips during 1993-1997, and 1999-2003. One harp seal was observed taken in 1998 (Table 2). Observed effort from 1993-2003 was scattered between New York and North Carolina from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 in 1995-1997, 17 in 1998 (1.02) and 0 in 1999-2003 In 2002, 65% of observer coverage was concentrated in one area and not distributed proportionally across the fishery. Therefore observed mortality is considered unknown in 2002. Average annual estimated fishery-related mortality attributable to this fishery during 1999-2003 was zero harp seals .

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. No mortalities were observed between 1991-2000, one mortality was observed in 2001, and zero mortalities were observed in 2002. Observer coverage, expressed as number of trips, was < 1% from 1998 to 2001, and 2% in 2002 (Table 2). The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 0 between 1991-2000, 49 (CV=1.10) in 2001, and 0 between 2002-2003. Average annual estimated fishery-related mortality attributable to this fishery in between 1999-2003 was 10 harp seals (CV=1.10) (Table 2). These estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

CANADA

An unknown number of harp seals have been taken in Newfoundland and Labrador groundfish gillnets (Read 1994). Harp seals are being taken in Canadian lumpfish and groundfish gillnets and trawls, but estimates of total removals have not been calculated to date. A recent analysis of bycatch in the Newfoundland lumpfish fishery indicates that fewer than 10,000 seals were taken annually from the start of the fishery in 1968 until 1984 (Walsh *et al.* 2000). Between 1984 and 1995, annual bycatches were more variable, ranging between 3,000 and 36,000 animals. Since 1996, bycatches have varied between 16,000 and 23,000 seals (DFO 2000), averaging 17,000 annually (Walsh *et al.* 2000, Anon. 2001).

In 1996, observers recorded 4 harp seals (1 released alive) in Spanish deep-water trawl fishing on the southern edge of the Grand Banks (NAFO Areas 3) (Lens 1997). Seal bycatches occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 2. Summary of the incidental mortality of harp seal (*Phoca groenlandica*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality[3]	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast Sink Gillnet	99-03	301	Obs. Data Weighout, Logbooks	.06, .06, .04, .02	4, 3, 1, 0,0	81, 24, 26, 0, 0	.78, 1.57, 1.04, 0, .0	26 (0.60)
Mid Atlantic Coastal Sink Gillnet	99-03	Unk[4]	Obs. Data Weighout	.02, .02, .02, .01	0, 0, 0, 0, 0	0, 0, 0, unk[5], 0	0, 0, 0, unk[5], 0	0 (0)
North Atlantic Bottom Trawl	99-03	970	Obs. Data Weighout	.001, .003, .003, .004, .021	0, 0, 0, 1, 0, 0	0, 0, 0, 49, 0	0, 0, 0, 1.10, 0	10 (1.10)
TOTAL								36 (0.53)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects landings data (Weighout) and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of fishing effort in the Northeast sink gillnet fishery.

2 The observer coverage for the Northeast sink gillnet fishery is measured in trips. Observer coverage for the mid-Atlantic coastal sink gillnet fishery is measured in tons of fish landed. North Atlantic bottom trawl fishery coverage is measured in trips.

3 In the Northeast sink gillnet fishery, 31 and 0 harp seals were taken on pingered trips during 1997 and 1998, respectively. During 1997, 1998, 1999, 2000 and 2001, there were 31, 4, 2, 2 and 1 harp seals observed on "mammal trips", respectively. See Bisack (1997) for "trip" type definitions. Between 1999 and 2001 respectively, 2, 1 and 0 harp seals were observed on "fish trips" and 3, 2 and 1 were observed taken from pingered nets.

4 Number of vessels is not known.

5 Sixty-five percent of sampling by the NEFSC fisheries observer program was concentrated in one area and not distributed proportionally across the fishery. Therefore, observed mortality is considered unknown in 2002. The previous five year average (97-01) estimated mortality was applied.

Other Mortality

Canada: Harp seals have been commercially hunted since the mid-1800's in the Canadian Atlantic (Stenson 1993). The total allowable catch (TAC) of harp seals in Canada has ranged from a low of 186,000 to a high of 350,000 between 1971 and 2003. Catches ranged from a low of 19,000 to a high of 312,367 over the same period. Low catches were reported between the years of 1983 and 1995 due to a limited market for seal products (Anon. 2003a). The Atlantic Seal Hunt 2003-2005 Management Plan (Anon. 2003a) allows for a three-year TAC of 975,000, with an annual TAC of up to 350,00 any one or two of the years, provided that the combined TAC over three years does not exceed 975,000.

Harp seals are also hunted in the Canadian Arctic and in Greenland (DFO 2000). There are no recent statistics for the Canadian Arctic, but Hammill and Stenson (2003) estimate the Arctic catch to be 4,811 annually. Prior to 1980, Greenland catches were fewer than 20,000 annually, but in recent years have dramatically increased to around 100,000 (DFO 2000). These number do not account for animals that are killed but not landed (struck and lost) (Lavigne 1999). A recent analysis of the struck and lost rates suggests that the rate for young seals (majority of Canadian take) is less than 5%, while losses of older seals, and seals taken in the Canadian Arctic and Greenland, are higher (approximately 50%) (Anon. 2001). The Healy and Stenson (2000) model for determining harp seal population incorporates struck-and-lost and bycaught seals.

U.S. From 1988 to 1993 strandings each year were under 50, approaching 100 animals in 1994, and exceeding 100 animals in 1995-1996 (Rubinstein 1994; B. Rubinstein, New England Aquarium, pers. comm.). From 1999 to 2003, 1,146 strandings were recorded (116 in 1999, 145 in 2000, 495 in 2001, 188 in 2002, and 97 in 2003) in all states between Maine and North Carolina (NMFS unpublished data). Factors contributing to a dramatic increase in strandings in 2001 are unknown (Harris *et al.* 2002). Twenty-three (2.0%) of the stranded animals during this five year period showed signs of human interaction as a direct cause of mortality. Mortalities caused by human interaction include boat strikes, fishing gear interactions, power plant entrainment, oil spills, harassment, and shooting.

The total number of harp seal strandings in 2003 is 97, of which 7 were healthy and did not require rehabilitation. Seventeen animals were rehabilitated and released. The remaining animals were either found dead or died in rehabilitation.

Table 3. Harp seal (*Phoca groenlandica*) reported strandings along the U.S. Atlantic coast (2002-2003).

State	2002	2003	Total
Maine	35	21	56
New Hampshire	1	1	2
Massachusetts	67	31	98
Rhode Island	10	6	16
Connecticut	12	1	13
New York	48	24	72
New Jersey	13	9	22
Delaware	0	1	1
Maryland	0	1	1
Virginia	1	0	1
North Carolina	1	2	3

STATUS OF STOCK

The status of the harp seal stock, relative to OSP, in the U..S Atlantic EEZ is unknown, but the population appears not to be increasing in Canadian waters. The species is not listed as threatened or endangered under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is believed to be very low relative to the population size in Canadian waters and can be considered insignificant and approaching zero mortality and serious injury rate. The level of human-caused mortality and serious injury in the U.S. Atlantic EEZ is believed to be very low relative to the total stock size; therefore, this is not a strategic stock.

REFERENCES

Anon. 2003a. Atlantic Seal Hunt: 2003-2005 management plan. Available from Canadian Department of Fisheries and Oceans, Ottawa, Ontario, Canada, K1A 0E6, Fisheries Resource Management – Atlantic. 34 pp.

Anon. 2003b. Report of the ICES/NAFO Working Group on Harp and Hooded Seals. 2-6 September 2003, Arkhangelsk, Russia. *ICES CM 2004/ACFM::06.* 57 pp.

Anon. 2001. Report on the Eminent Panel on Seal Management. Available from Canadian Department of Fisheries and Oceans, Ottawa, Ontario, Canada, K1A 0E6, Communication Branch. 145pp.

Anon. 2000. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals. 2-6 October 2000, Copenhagen, Denmark. *ICES CM 2001/ACFM:08.* 40 pp.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise bycatch in the Gulf of Maine sink gillnet fishery, 1990-93. *Rep. int Whal. Commn.* 46:567-574.

Bisack, K. D. 1997. Harbor porpoise bycatch estimates in the New England multispecies sink gillnet fishery: 1994 and 1995. *Rep. int Whal. Commn.* 47:705-14.

Bonner, W. N. 1990. The natural history of seals. *Fact on File*, New York, 196 pp.

Bowen, W. D. and D. E. Sergeant. 1983. Mark-recapture estimates of harp seal pup (*Phoca groenlandica*) production in the northwest Atlantic. *Can. J. Fish. Aquat. Sci.* 40: 728-742.

Bowen, W. D. and D. E. Sergeant. 1985. A mark-recapture estimate of 1983 harp seal pup production in the Northwest Atlantic. *NAFO SCR*. Doc. 85/I/1.

CAFSAC. 1992. Update on population estimates of Harp seal in the Northwest Atlantic. Canadian Atlantic Fisheries Scientific Advisory Committee, *CAFSAC* Adv. Doc. 92/8.

DFO [Dept. Of Fisheries and Oceans]. 2000. Northwest Atlantic harp seals. DFO Science Stock Status Report E1-01. Available from the Canadian Stock Assessment Secretariat, Ottawa, Ontario.

Hammill, M. O. and G. B. Stenson. 2003. Harvest simulations for 2003-2006 harp seal management plan. *Can. Sci. Advisory Sec. Res. Doc.* 2003/068.

Harris, D. E., B. Lelli, and G. Jakush. 2002. Harp seal records from the southern Gulf of Maine: 1997-2001. *Northeastern Naturalist 9(3):331-340.*

Healey, B. P., and G. B. Stenson. 2000. Estimating pup production and population size of the northwest Atlantic harp seal (*Phoca groenlandica*). *Can. Stock Assess. Sec. Res. Doc*. 2000/081.

Johnston, D. W., P., Meisenheimer, and D. M. Lavigne. 2000. An evaluation of management objectives for Canada's commercial harp seal hunt, 1996-1998. *Cons. Biol*. 14: 729-737.

Katona, S. K., V. Rough and D. T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. *Smithsonian Institution Press*, Washington, DC. 316 pp.

Lacoste, K. N. and G. B. Stenson. 2000. Winter distribution of harp seals (*Phoca groenlandica*) off eastern Newfoundland and southern Labrador. *Polar Biol. 23: 805-811.*

Lavigne, D. M. and K. M. Kovacs. 1988. Harps and Hoods Ice Breeding Seals of the Northwest Atlantic. *University of Waterloo Press*, Waterloo, Ontario, Canada, 174 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES C.M.* 8/Q. 10 pp.

McAlpine, D. F. 1999. Increase in extralimital occurrences of ice-breeding seals in the northern Gulf of Maine region: more seals or fewer fish. *Mar. Mammal Sci., 15: 906-911.*

McAlpine , D. F. and R. H. Walker. 1990. Extralimital records of the harp seal, *Phoca groenlandica*, from the western North Atlantic: a review. *Mar. Mammal Sci.* 6:243-247.

Roff, D. A. and W. D. Bowen. 1983. Population dynamics and management of the Northwest Atlantic harp seal. *Can. J. Fish. Aquat. Sci.* 40: 919-932.

Ronald, K. and P. J. Healey. 1981. Harp Seal. Pages 55-87 *in:* S. H. Ridgway and R. J. Harrison (eds), Handbook of marine mammals, Vol. 2: Seals. *Academic Press*, New York, 359 pp.

Rubinstein, B. 1994. An apparent shift in distribution of ice seals, *Phoca groenlandica*, *Cystophora cristata*, and *Phoca hispida*, toward the east coast of the United States. M.A. Thesis, Boston University, Boston, MA, 45 pp.

Sergeant, D. E. 1965. Migrations of harp seal *Pagophilus groenlandicus* (Erxleben) in the Northwest Atlantic. *J. Fish. Res. Bd. Can.* 22:433-464.

Sergeant, D. E. 1975. Estimating numbers of harp seals. *Rapp. P. -v. Reun. Cons. int Explor. Mer.* 169: 274-280.

Shelton, P. A., N. G. Caddigan and G. B. Stenson. 1992. Model estimates of harp seal population trajectories in the Northwest Atlantic. *CAFSAC Res. Doc*. 92/89, 23 pp.

Shelton, P. A., G. B. Stenson, B. Sjare and W. G. Warren. 1996. Model estimates of harp seal numbers-at-age for the Northwest Atlantic. *NAFO Sci. Coun. Studies* 26:1-14.

Sjare, B., G. B. Stenson and W. G. Warren. 1996. Summary of female harp seal reproductive parameters in the Northwest Atlantic. *NAFO Sci. Coun. Studies* 26:41-46.

Sjare, B. and G. B. Stenson. 2000. Recent estimates of reproductive rates for harp seals in the Northwest Atlantic. Can. Stock Assess. Sec. Res. Doc. 2000/077.

Stenson, G. B. 1993. The status of pinnipeds in the Newfoundland region. *NAFO SCR Doc*. 93/34.

Stenson, G. B. and B. Sjare. 1997. Seasonal distribution of harp seals, *Phoca groenlandica*, in the Northwest Atlantic. *ICES C.M.* 1997/CC:10 (Biology and Behavior II). 23 pp.

Stenson, G. B., L. P. Rivest, M. O. Hammill, J. F. Gosselin, B. Sjare. 2003. Estimating pup production of harp seals, *Pagophilus groenlandicus*, in the Northwest Atlantic. *Mar. Mam. Sci.* 19(1):141-160.

Stenson, G. B., M. O. Hammill, J. F. Gosselin and B. Sjare. 2000. 1999 pup production of harp seals, *Phoca groenlandica*, in the northwest Atlantic. Can. Stock Assess. Sec. Res. Doc. 2000/080.

Stenson, G. B., M. O. Hammill, M. C. S. Kingsley, B. Sjare, W. G. Warren and R. A. Myers. 2002. Is there evidence of increased pup productioon in northwest Atlantic harp seals, *Pagophilus groenlandicus*? *ICES J. Mar. Sci.* 59:81-92.

Stenson, G. B., M. O. Hammill, M. C. S. Kingsley, B. Sjare, W. G. Warren and R. A. Myers. 1996. 1994 pup production of Northwest Atlantic harp seals, *Phoca groenlandica*. *NAFO Sci. Coun. Studies* 26: 47-62.

Stenson, G. B., R. A. Myers, M. O. Hammill, I-H Ni, W. G. Warren and M. S. Kingsley. 1993. Pup production of harp seals, *Phoca groenlandica*, in the Northwest Atlantic. *Can. J. Fish. Aquat. Sci.* 50: 2429-2439.

Stevick, P. T. and T. W. Fernald. 1998. Increase in extralimital records of harp seals in Maine. *Northeastern Naturalist* 5(1)75-82.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walsh, D., B. Sjare and G. B. Stenson. 2000. Preliminary estimates of harp seal bycatch in the Newfoundland lumpfish fishery. Can. Stock Assess. Sec. Res. Doc. 2000/078.

Warren, W. G., P. A. Shelton and G. B. Stenson. 1997. Quantifying some of the major sources of uncertainty associated with estimates of harp seal prey consumption. Part 1: Uncertainty in the estimates of harp seal population size. *J. Northwest Atl. Fish. Sci*., 22: 289-302.

November 2004

HOODED SEAL (*Cystophora cristata*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The hooded seal occurs throughout much of the North Atlantic and Arctic Oceans (King 1983) preferring deeper water and occurring farther offshore than harp seals (Sergeant 1976; Campbell 1987; Lavigne and Kovacs 1988; Stenson *et al.* 1996). Hooded seals tend to wander far out of their range and have been seen as far south as Puerto Rico (Mignucci-Giannoni and Odell 2001), with increased occurrences from Maine to Florida. These appearances usually occur between January and May in New England waters, and in summer and autumn off the southeast U.S. coast and in the Caribbean (McAlpine *et al.* 1999; Harris *et al.* 2001; Mignucci-Giannoni and Odell 2001). Although it is not known which stock these seals come from, it is known that during spring, the northwest Atlantic stock of hooded seals are at their southern most point of migration in the Gulf of St. Lawrence. The world's hooded seal population is divided into three separate stocks, each identified with a specific breeding site (Lavigne and Kovacs 1988; Stenson *et al.* 1996). One stock, which whelps off the coast of eastern Canada, is divided into two breeding herds (Front and Gulf) which breed on the pack ice. The Front herd (largest) breeds off the coast of Newfoundland and Labrador and the Gulf herd breeds in the Gulf of St. Lawrence. The second stock breeds in the Davis Strait, and the third stock occurs on the West Ice off eastern Greenland.

Hooded seals are a highly migratory species. Hooded seals remain on the Newfoundland continental shelf during winter/spring (Stenson *et al.* 1996). Breeding occurs at about the same time in March for each stock. Adults from all stocks then assemble in the Denmark Strait to molt between late June and August (King 1983; Anon 1995), and following this, the seals disperse widely. Some move south and west around the southern tip of Greenland, and then north along the west coast of Greenland. Others move to the east and north between Greenland and Svalbard during late summer and early fall (Lavigne and Kovacs 1988). Little else is known about the activities of hooded seals during the rest of the year until they assemble again in February for breeding.

POPULATION SIZE

The number of hooded seals in the western North Atlantic is unknown. Seasonal abundance estimates are available based on a variety of analytical methods based on commercial catch data, and also include aerial surveys. These methods often include surveying the whelping concentrations and modeling the pup production. Several estimates of pup production at the Front are available. Hooded seal pup production between 1966 and 1977 was estimated at 25,000 - 32,000 annually (Benjaminsen and Oritsland 1975; Sergeant 1976b; Lett 1977; Winters and Bergflodt 1978; Stenson *et al.* 1996). Estimated pup production dropped to 26,000 hooded seal pups in 1978 (Winters and Bergflodt 1978). Pup production estimates began to increase after 1978, reaching 62,000 (95% CI. 43,700 - 89,400) by 1984 (Bowen *et al.* 1987). Bowen *et al.* (1987) also estimated pup production in the Davis Strait at 18,600 (95% C.I. 14,000 - 23,000). A 1985 survey at the Front (Hay *et al.* 1985) produced an estimate of 61,400 (95% C.I. 16,500 - 119,450). Hammill *et al.* (1992) estimated pup production to be 82,000 (SE=12,636) in 1990. Assuming a ratio of pups to total population of 1:5, pup production in the Gulf and Front herds would represent a total population of approximately 400,000-450,000 hooded seals (Stenson 1993). Based on the 1990 survey, Stenson *et al.* (1996) suggested that pup production may have increased at about 5% per year since 1984. However, because of exchange between the Front and the Davis Strait stocks, the possibility of a stable or slightly declining level of pup production is also likely (Stenson 1993; Stenson *et al.* 1996). In 1998 and 1999, surveys were conducted to estimate pup production in the southern Gulf of St. Lawrence, which is the smallest component of the northwest Atlantic stock (Anon. 2001a). The estimate of 2,000 was similar to the previous published 1990 estimate (Hammill *et al.* 1992; Anon. 2001a). There are no current estimates of pup production for the Davis Strait or the Front breeding groups. The stock has not been surveyed since 1990, but a pup survey is planned for March 2005 (Anon 2003).

Minimum population estimate

Present data are insufficient to calculate the minimum population estimate for U.S. waters. Since there are no recent comprehensive pup production counts it is not possible to assess current population size (Anon. 2001a).

Current population trend

There are no current data to assess the status of the population in either Canadian or U.S. waters.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. The most appropriate data are based on Canadian studies. The most recent comprehensive pup production survey (1990) is nearly 13 years old, which exceeds the GAMMS (Wade and Angliss 1997) criterion (e.g., >8 years) for reliable abundance data.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.12, the default value for pinnipeds. The recover factor (F_R) for this stock is 0.5, the value for stocks with unknown population status. PBR for the western North Atlantic hooded seal in U.S. waters is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 1999-2003, the total estimated human caused mortality and serious injury to hooded seals was 5,594. This is derived from two components: 1) 5,578 from 1999-2003 (1999 = 3,375 ; 2000 = 5,988; 2001 6,414 ; 2002 = 6,056[1]; and 2003 = 6,056[1]) average catches of Northwest Atlantic population of hooded seals by Canada and Greenland; and 2) 16 hooded seals (CV=1.14) from the observed U.S. fisheries (Table 1) ([1]2000-2001 average Greenland catches).

In 1974 total allowable catch (TAC) was set at 15,000, and reduced to 12,000 in 1983 and to 2,340 in 1984 (Stenson 1993; Anon 1998). From 1991-1992 the TAC was increased to 15,000. A TAC of 8,000 was set for 1993, and held at that level through 1997. Since 1998, the TAC has been set at 10,000 (Anon 2003). From 1974 through 1982, the average catch was 12,800 animals, mainly pups. Since 1983 catches ranged from 33 in 1986 to 6,425 in 1991, with a mean catch of 1,001 between 1983 and 1995. In 1996 catches (25,754) were more than three times the allowable quota (Anon 1998). The high catch was attributable to good ice conditions and strong market demand. Catches in 1997 were 7,058, slightly below the TAC. Since 2000, catches in have ranged between 5,000-6,000 animals (Anon 2003).

Hunting in the Gulf of St. Lawrence (below 50^0N) has been prohibited since 1964. No commercial hunting of hooded seals is permitted in the Davis Strait.

Total annual estimated average fishery-related mortality or serious injury to this stock in U.S. waters during 1999-2003 was 16 hooded seals (CV=1.14; Table 1).

Fishery Information

U.S.

Detailed fishery information are reported in Appendix III. Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Recent bycatch has been observed by NMFS Sea Samplers in the Northeast sink gillnet fisheries, but no mortalities have been documented in the mid-Atlantic coastal gillnet, Atlantic drift gillnet, pelagic pair trawl or pelagic longline fisheries.

In 1993, there were approximately 349 full- and part-time vessels in the Northeast sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, 4%, 6%, 5%, 6%, 6% and 4% for 1990 to 2001, respectively. The fishery has been observed in the Gulf of Maine and in southern New England. There were 2 hooded seal mortalities observed in the Northeast sink gillnet fishery between 1990 and 2001. Annual estimates of hooded seal bycatch in the Northeast sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-2001 was 0 in 1990-1994, 28 in 1995 (0.96), 0 in 1996-2000 and 82 in 2001 (1.14). The 1995 bycatch includes 5 animals from the estimated number of unknown seals (based on observed mortalities of seals that could not be identified to species). The unknown seals were prorated, based on spatial/temporal patterns of bycatch of harbor seals, gray seals, harp seals, and hooded seals. Since 1997, unidentified seals have not been prorated to a species. This is consistent with the treatment of other unidentified mammals that do not get prorated to a specific species. There were 0, 1, 5 and 8 unidentified seals observed during 1998 through 2001, respectively. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1999-2003was 16 hooded seals (CV=1.14). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch in 2001 occurred in summer (July-September). All bycatch was in waters between Cape Ann and New Hampshire.

CANADA

An unknown number of hooded seals have been taken in Newfoundland and Labrador groundfish gillnets (Read 1994).

Hooded seals are being taken in Canadian lumpfish and groundfish gillnets and trawls; however, estimates of total removals have not been calculated to date.

Table 1 . Summary of the incidental mortality of hooded seal (*Cystophora cristata*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast Sink Gillnet	99-03	301	Obs. Data Weighout, Logbooks	.06,.06, .04, 02	0, 0,1, 0, 0	0, 0, 82, 0, 0	0, 0, 1.14, 0, 0	16 (1.14)
TOTAL								16 (1.14)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout (Weighout) landings data, and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the Northeast sink gillnet fishery.

2 The observer coverage for the Northeast sink gillnet fishery is measured in trips.

3 Only mortalities observed on marine mammal trips were used to estimate total hooded seal bycatch. See Bisack (1997) for “trip” type definitions. The one hooded seal mortality observed in 2001 was taken in a net equipped with pingers.

Other Mortality

In Atlantic Canada, hooded seals have been commercially hunted at the Front since the late 1800's. In 1974 total allowable catch (TAC) was set at 15,000, and reduced to 12,000 in 1983 and to 2,340 in 1984 (Stenson 1993; Anon 1998). From 1991 to 1992 the TAC was increased to 15,000. A TAC of 8,000 was set for 1993, and held at that level through 1997. From 1974 through 1982, the average catch was 12,800 animals, mainly pups. Since 1983 catches ranged from 33 in 1986 to 6,425 in 1991, with a mean catch of 1,001 between 1983 and 1995. In 1996 catches (25,754) were more than three times the allowable quota (Anon 1998). The high catch was attributable to good ice conditions and strong market demand. The TAC has remained at 10,000 since 1998 but catches have been very low (e.g., 10 (2000)and 151 (2003); Anon. 2001b; Anon 2003; Stenson, unpublished data). Greenland catches remained below 5,000 during the period 1954-1975, but increased to 5,000-7,000 and 6,300-9,900, respectively, during the periods 1976-1992 and 1993-1998 (Anon. 2001a). A series of management regulations have been implemented since 1960. For example, hunting in the Gulf of St. Lawrence (below 50^0N) has been prohibited since 1965, no commercial hunting of hooded seals is permitted in the Davis Strait, and in 2000, the taking of bluebacks was prohibited (Anon. 2001a).

In 1988-1993, strandings were fewer than 20 per year, and from 1994 to 1996 they increased to about 50 per year (Rubinstein 1994; Rubinstein, pers. comm). From 1999 to 2003, 200 hooded seal strandings were reported (1999=36; 2000=30, 2001=86, 2002=30, and 2003=18), in most states from Maine to Virginia (Table 3; NMFS unpublished data). Three (1.5%) of the seals stranded during this five year period showed signs of human interaction as a direct cause of mortality. [1 in 1999, 1 in 2000, and 1 in 2003. Extralimital strandings have also been reported off the southeast U.S., North Carolina to Florida, and in the Caribbean (McAlpine *et al.* 1999; Mignucci-Giannoni and Odell 2001; NMFS, unpubl. data).

Table 3. Hooded seal (*Cystophora cristata*) reported strandings along the U.S. Atlantic coast (2002-2003).

State	2002	2003	Total
Maine	14	10	24
New Hampshire	1	1	2
Massachusetts	10	4	14
Rhode Island	0	0	0
Connecticut	0	0	0
New York	2	0	2
New Jersey	2	2	4
Delaware	1	1	2
Maryland	0	0	0
Virginia	0	0	0

STATUS OF STOCK

The status of hooded seals relative to OSP in U.S. Atlantic EEZ is unknown, but the population appears to be increasing in Canada. They are not listed as threatened or endangered under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is believed to be very low relative to the population size in Canadian waters and can be considered insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because the level of human-caused mortality and serious injury is believed to be very low relative to overall stock size.

REFERENCES

Anon. 1995. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals. 5-9 June 1995, Dartmouth, Nova Scotia Canada. *NAFO SCS Doc. 95/16. Serial No. N2569. 40 pp.*

Anon. 1998. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals. 28 August - 3 September 1997, Copenhagen, Denmark. *ICES CM 1998/Assess:3. 35 pp.*

Anon. 2001a. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals. 2-6 October 2000, Copenhagen, Denmark. *ICES CM 2001/ACFM:08. 40 pp.*

Anon. 2001b. Atlantic Seal Hunt: 2001 management plan. Available from Canadian Department of Fisheries and Oceans, Ottawa, Ontario Canada, K1A OE6, Resource Management - Atlantic. 34 pp.

Anon 2003. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals. 2-6 September 2003, Arkhanglesk, Russia. *ICES CM 2004/ACFM:06* 53 pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Benjaminsen, T., and T. Oritsland. 1975. The survival of year-classes and estimates of production and sustainable yield of northwest Atlantic harp seals. *Int. Comm. Northwest Atl. Fish. Res. Doc. 75/121.*

Bowen, W.D., R.A. Myers and K. Hay. 1987. Abundance estimation of a dispersed, dynamic population: Hooded seals (*Cystophora cristata*) in the Northwest Atlantic. *Can. J. Fish. Aquat. Sci. 44: 282-295.*

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise bycatch in the Gulf of Maine sink gillnet fishery, 1990-93. *Rep. int. Whal. Commn. 46:567-574.*

Campbell, R. R. 1987. Status of the hooded seal, *Cystophora cristata*, in Canada. *Can. Field.-Nat. 101: 253-265*.

Hammill, M. O., G. B. Stenson, and R. A. Myers. 1992. Hooded seal (*Cystophora cristata*) pup production in the Gulf of St. Lawrence. *Can. J. Fish. Aquat. Sci. 49: 2546-2550.*

Harris, D. E., B. Lelli, G. Jakush, and G. Early. 2001. Hooded seal (*Cystophora cristata*) records from the southern Gulf of Maine. *Northeastern Naturalist. 8: 427-434*.

Hay, K., G. B. Stenson, D. Wakeham, and R. A. Myers. 1985. Estimation of pup production of hooded seals (*Cystophora cristata*) at Newfoundland during March 1985. *Can. Atl. Fish. Sci. Adv. Comm. 85/96*.

King, J. E. 1983. Seals of the World. *Cornell University Press*, Ithaca, NY, 240 pp.

Lavigne, D. M. and K. M. Kovacs. 1988. Harps and Hoods Ice Breeding Seals of the Northwest Atlantic. *University of Waterloo Press*, Waterloo, Ontario, Canada, 174 pp.

Lett, P.F. 1977. A model to determine stock size and management options for the Newfoundland hooded seal stock. *Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 77/25*.

Mignucci-Giannoni, A. A. and D. K. Odell. 2001. Tropical and subtropical records of hooded seals (*Cystophora cristata*) dispel the myth of extant Caribbean monk seals (*Monachus tropicalis*). *Carib. Bull. Mar. Sci., 68: 47-58*.

McAlpine, D. F., P. T. Stevick, L. D. Murison, and S. D. Turnbull. 1999. Extralimital records of hooded seals (*Cystophora Cristata*) from the Bay of Fundy and northern Gulf of Maine. *Northeastern Naturalist 6: 225-230*.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Rubinstein, B. 1994. An apparent shift in distribution of ice seals, *Phoca groenlandica*, *Cystophora cristata*, and *Phoca hispida*, toward the east coast of the United States. M.A. Thesis, Boston University, Boston, MA, 45 pp.

Sergeant, D.E. 1976a. History and present status of populations of harp and hooded seals. *Biol. Conserv. 10:95-117.*

Sergeant, D.E. 1976b. Research on hooded seals *Cystophora cristata* Erxleben in 1976. *ICNAF Res. Doc. 76/X/126*.

Stenson, G. B. 1993. The status of pinnipeds in the Newfoundland region. *NAFO SCR Doc. 93/34.*

Stenson, G.B., R.A. Myers, I-H Ni and W.G. Warren. 1996. Pup production of hooded seals (*Cystophora cristata*) in the Northwest Atlantic. *NAFO Sci. Coun. Studies 26:105-114.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walden, J. 1996. The New England gillnet effort survey. NOAA, NMFS, NEFSC Ref. Doc. 99-10. 38p. Available from: NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA, 02543.

Winters, G. H. And B. Bergflodt. 1978. Mortality and productivity of the Newfoundland hooded seal stock. *ICNAF Res. Doc. 78/XI/91*.

FIN WHALE (*Balaenoptera physalus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The Scientific Committee of the International Whaling Commission (IWC) has proposed stock boundaries for North Atlantic fin whales. Fin whales off the eastern U.S. north to Nova Scotia and the southeastern coast of Newfoundland are believed to constitute a single stock under the present IWC scheme (Donovan 1991). However, the stock identity of North Atlantic fin whales has received relatively little attention, and whether the current stock boundaries define biologically isolated units has long been uncertain. The existence of a subpopulation structure was suggested by local depletions that resulted from commercial overharvesting (Mizroch et al. 1984).

A genetic study conducted by Bérubé et al. (1998) using both mitochondrial and nuclear DNA provided strong support for an earlier population model proposed by Kellogg (1929) and others. This postulates the existence of several subpopulations of fin whales in the North Atlantic and Mediterranean, with limited gene flow among them. Bérubé et al. (1998) also proposed that the North Atlantic population showed recent divergence due to climatic changes (i.e. postglacial expansion), as well as substructuring over even relatively short distances. The genetic data are consistent with the idea that different subpopulations use the same feeding ground, a hypothesis that was also originally proposed by Kellogg (1929).

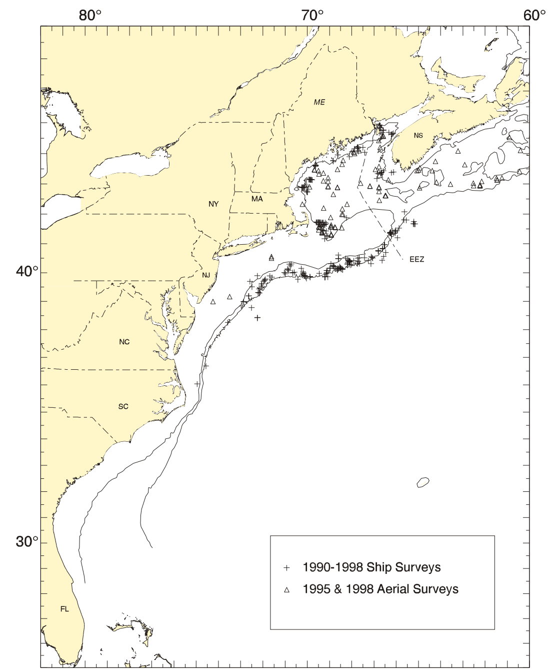

Figure 1. *Distribution of fin whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.*

Fin whales are common in waters of the U.S. Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras northward (Figure 1). Fin whales accounted for 46% of the large whales and 24% of all cetaceans sighted over the continental shelf during aerial surveys (CETAP 1982) between Cape Hatteras and Nova Scotia during 1978-82. While a great deal remains unknown, the magnitude of the ecological role of the fin whale is impressive. In this region fin whales are probably the dominant large cetacean species in all seasons, with the largest standing stock, the largest food requirements, and therefore the largest impact on the ecosystem of any cetacean species (Kenney et al. 1997; Hain et al. 1992

There is little doubt that New England waters represent a major feeding ground for the fin whale. There is evidence of site fidelity by females, and perhaps some segregation by sexual, maturational or reproductive class on the feeding range (Agler et al. 1993). Seipt et al. (1990) reported that 49% of identified fin whales on Massachusetts Bay area feeding grounds were resighted within the same year, and 45% were resighted in multiple years. While recognizing localized as well as more extensive movements, these authors suggested that fin whales on these grounds exhibited patterns of seasonal occurrence and annual return that are in some respects similar to those shown for humpback whales. This was reinforced by Clapham and Seipt (1991), who showed maternally directed site fidelity by fin whales in the Gulf of Maine. Information on life history and vital rates is also available in data from the Canadian fishery, 1965-1971 (Mitchell 1974). In seven years, 3,528 fin whales were taken at three whaling stations. The station at Blandford, Nova Scotia, took 1,402 fin whales.

Hain et al. (1992), based on an analysis of neonate stranding data, suggested that calving takes place during approximately four months from October to January in latitudes of the U.S. mid-Atlantic region; however, it is unknown where calving, mating, and wintering for most of the population occurs. Results from the Navy's SOSUS program (Clark 1995) indicate a substantial deep-ocean component to fin whale distribution. It is likely that fin whales occurring in the U.S. Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions. However, the popular notion that entire fin whale populations make distinct annual migrations like some other mysticetes has questionable support in the data; in the North Pacific, year-round monitoring of fin whale calls found no evidence for large-scale migratory movements (Watkins et al. 2000).

POPULATION SIZE

Two estimates of abundance from line-transect surveys are available. An abundance of 2,200 (CV=0.24) fin whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence. Data collection and analysis methods used were described in Palka (1995).

A more recent estimate of 2,814 (CV=0.21) fin whales was derived from a 28 July to 31 August 1999 line-transect sighting survey conducted by a ship and airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence. Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)* (Palka 2000).

The latter abundance estimate is considered the best available for the western North Atlantic fin whale because it is relatively recent. However, this estimate must be considered extremely conservative in view of the known range of the fin whale in the entire western North Atlantic, the uncertainties regarding population structure and exchange between surveyed and unsurveyed areas, and aerial data having not been corrected for *g(0)*.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for fin whales is 2,814 (CV=0.21). The minimum population estimate for the western North Atlantic fin whale is 2,362.

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Based on photographically identified fin whales, Agler et al. (1993) estimated that the gross annual reproduction rate was at 8%, with a mean calving interval of 2.7 years.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow et al. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 2,362. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the fin whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic fin whale is 4.7.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The number of fin whales taken at 3 whaling stations in Canada from 1965 to 1971 totaled 3,528 whales (Mitchell 1974). Reports of non-directed takes of fin whales are fewer over the last two decades than for other endangered large whales such as right and humpback whales. There was no reported fishery-related mortality or serious injury to fin whales in fisheries observed by NMFS during 1999 through 2003. A review of NMFS records from 1999 through 2003 yielded an average of 1.4 human-caused mortalities per year – 0.4 per year resulting from fishery interactions/entanglements (U.S. waters, 0.2; Bermudian waters, 0.2), and 1.0 due to vessel collisions--all in U.S. waters (Table 1).

Fishery-Related Serious Injury and Mortality

No confirmed fishery-related mortality or serious injury of fin whales was reported in the NMFS Sea Sampling bycatch database. A review of the records of stranded, floating or injured fin whales for the period 1999 through 2003 on file at NMFS found two records with substantial evidence of fishery interactions causing mortality (Table 1), which results in an annual rate of serious injury and mortality of 0.4 fin whales from fishery interactions. While these records are not statistically quantifiable in the same way as the observed fishery records, they give a minimum estimate of the frequency of entanglements for this species. In addition to the records above, there are were 5 records of entanglement within the period that either lacked substantial evidence for a serious injury determination, or that did not provide the detail necessary to determine if an entanglement had been a contributing factor in the mortality.

Table 1. Summarized records of mortality and serious injury likely to result in mortality, Westernwestern North Atlantic fin whale stock, January 19971999 - December 20012003. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFSNOAA Fisheries.

Date	Report Type	Sex, age, ID length	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh.inter	
2/10/99	mortality	5 m male	Virginia Beach, VA	P		large external wound, extensive fractures to vertebral column, hemorrhaging
11/5/99	mortality	16.2 m male	Elizabeth, NJ	P		large wound anterior of the blowhole, severed left flipper, shattered bones
12/11/00	mortality	10.9 m female	New York harbor	P		hemorrhage and fractured bones on right side
1/2/01	mortality	18.1 m female	New York harbor	P		dorsal abrasion marks, hematoma
2/1/01	mortality	14.5 m female	Port Elizabeth, NJ	P		Very fresh carcass hung on ship's bow
9/19/01	mortality	10.7 m unknown	off Bermuda		P	Extensive fresh entanglement marks
7/28/02	mortality	unknown	Georges Bank		P	Heavy line seen on tail stock, appeared embedded

Table notes:

1. The date sighted and location provided in the table are not necessarily when or where the serious injury or mortality occurred; rather, this information indicates when and where the whale was first reported beached, entangled, or injured.
2. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (62 FR 33, Jan. 2, 1997) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
3. Assigned cause based on best judgement of available data. Additional information may result in revisions.

Other Mortality

After reviewing NMFS records for 1999 through 2003, 5 were found that had sufficient information to confirm the cause of death as collisions with vessels (Table 1). One record (8/4/97) had been omitted from previous reports, but is inserted here following an examination of the exhumed skeletal remains which found a broken jaw and cracked scapula which had partially healed. The partial healing indicates the whale was alive at the time of the incident.

These records constitute an annual rate of serious injury or mortality of 1.0 fin whales from collisions with vessels. NMFS data holdings include four additional records of fin whale collisions with vessels, but the available supporting documentation was insufficient to determine if the whales sustained mortal injuries from the encounters.

STATUS OF STOCK

The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine the population trend for fin whales. The total level of human-caused mortality and serious injury is unknown. The records on hand at NMFS represent coverage of only a portion of the area surveyed for the population estimate for the stock. The total fishery-related mortality and serious injury for this stock derived from the available records is less than 10% of the calculated PBR. However, this is a strategic stock because the fin whale is listed as an endangered species under the ESA. A Recovery Plan for fin whales has been prepared and is currently awaiting legal clearance.

REFERENCES

Agler, B. A., R. L. Schooley, S. E. Frohock, S. K. Katona, and I. E. Seipt. 1993. Reproduction of photographically identified fin whales, *Balaenoptera physalus*, from the Gulf of Maine. *J. Mamm*. 74(3): 577-587.

Barlow, J., S. L. Swartz, T. C. Eagle, and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. NOAA Technical Memorandum NMFS-OPR-6. U.S. Department of Commerce, Washington, DC. 73 pp.

Bérubé, M., A. Aguilar, D. Dendanto, F. Larsen, G. Notarbartolo di Sciara, R. Sears, J. Sigurjónsson, J. Urban-R. and P. J. Palsbøll. 1998. Population genetic structure of North Atlantic, Mediterranean and Sea of Cortez fin whales, *Balaenoptera physalus* (Linnaeus 1758): analysis of mitochondrial and nuclear loci. *Mol. Ecol.* 15: 585-599.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Clapham, P. J. and I. E. Seipt. 1991. Resightings of independent fin whales, *Balaenoptera physalus*, on maternal summer ranges. *J. Mamm.* 72: 788-790.

Clark, C. W. 1995. Application of U.S. Navy underwater hydrophone arrays for scientific research on whales. *Rep. int. Whal. Commn.* 45: 210-212.

Donovan, G. P. 1991. A review of IWC stock boundaries. *Rep. int. Whal. Commn.* Special Issue 13: 39-68.

Hain, J. H. W., M. J. Ratnaswamy, R. D. Kenney, and H. E. Winn. 1993. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. *Rep. int. Whal. Commn.* 42: 653-669.

Kellogg, R. 1929. What is known of the migration of some of the whalebone whales. *Ann. Rep. Smithsonian Inst.* 1928: 467-494.

Kenney, R. D., G. P. Scott, T. J. Thompson, and H. E. Winn. 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. *J. Northw. Atl. Fish. Sci.* 22: 155-171.

Mizroch, A. A., D. W. Rice and J. M. Breiwick. 1984. The fin whale, *Balaenoptera physalus*. *Mar. Fisheries Rev*. 46: 20-24.

Mitchell, E. 1974. Present status of northwest Atlantic fin and other whale stocks. Pages 109-169. *In:* W. E. Schevill (ed), *The whale problem: A status report*. Harvard University Press, Cambridge, Massachusetts, 419 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. *Rep. int. Whal. Commn*. Special Issue 16: 27-50.

Palka, D. 2000. Abundance of the Gulf of Maine/Bay of Fundy harbor porpoise based on shipboard and aerial surveys during 1999. NMFS, Northeast Fisheries Science Center Ref. Doc. 00-07; 29 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543.

Seipt, I. E., P. J. Clapham, C. A. Mayo and M. P. Hawvermale. 1990. Population characteristics of individually identified fin whales, *Balaenoptera physalus*, in Massachusetts Bay. *Fish. Bull., U.S.* 88(2): 271-278

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop, April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12. U.S. Dept. of Commerce, Washington, DC. 93 pp.

Watkins, W.A., M.A. Daher, G.M. Reppucci, J.E. George, D.L. Martin, N.A. DiMarzio and D.P. Gannon. 2000. Seasonality and distribution of whale calls in the North Pacific. *Oceanography* 13: 62-67.

HUMPBACK WHALE (*Megaptera novaeangliae*): Gulf of Maine Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the western North Atlantic, humpback whales feed during spring, summer and fall over a range which encompasses the eastern coast of the United States (including the Gulf of Maine), the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland (Katona and Beard 1990). Other North Atlantic feeding grounds occur off Iceland and northern Norway, including off Bear Island and Jan Mayen (Christensen et al. 1992; Palsbøll et al. 1997). These six regions represent relatively discrete subpopulations, fidelity to which is determined matrilineally (Clapham and Mayo 1987). Genetic analysis of mitochondrial DNA (mtDNA) has indicated that this fidelity has persisted over an evolutionary timescale in at least the Icelandic and Norwegian feeding grounds (Palsbøll et al. 1995; Larsen et al. 1996).

Previously, the North Atlantic humpback whale population was treated as a single stock for management purposes (Waring et al. 1999). Indeed, earlier genetic analyses (Palsbøll et al. 1995), based upon relatively small sample sizes, had failed to discriminate among the four western North Atlantic feeding areas. However, genetic analyses often reflect a timescale of thousands of years, well beyond those commonly used by managers. Accordingly, the decision was recently made to reclassify the Gulf of Maine as a separate feeding stock; this was based upon the strong fidelity by individual whales to this region, and the attendant assumption that, were this subpopulation wiped out, repopulation by immigration from adjacent areas would not occur on any reasonable management timescale. This reclassification has subsequently been supported by new genetic analysis based upon a much larger collection of samples than those utilized by Palsbøll et al. (1995). These analyses have found significant differences in mtDNA haplotype frequencies of the four western feeding areas, including the Gulf of Maine (Palsbøll et al. 2001). During the recent Comprehensive Assessment of North Atlantic humpback whales, the International Whaling Commission acknowledged the evidence for treating the Gulf of Maine as a separate stock for the purpose of management (IWC 2002).

During the summers of 1998 and 1999, the Northeast Fisheries Science Center conducted surveys for humpback whales on the Scotian Shelf. The objective of these surveys was to establish the occurrence and population identity of the animals found in this region, which lies between the well-studied populations of the Gulf of Maine and Newfoundland. Photographs from both surveys have now been compared to both the overall North Atlantic Humpback Whale Catalogue and a large regional catalogue from the Gulf of Maine (maintained by the College of the Atlantic and the Center for Coastal Studies, respectively); this work is summarized in Clapham et al. (2003). The match rate between the Scotian Shelf and the Gulf of Maine was 27% (14 of 52 Scotian Shelf individuals from both years). Comparable rates of exchange were obtained from the southern (26%, n=10 of 36 whales) and northern (27%, *n*=4 of 15 whales) ends of the Scotian Shelf, despite the additional distance of nearly 100 nautical miles (one whale was observed in both areas). In contrast, all (36 of 36) humpback whales identified by the same NMFS surveys elsewhere in the Gulf of Maine (including Georges Bank, southwestern Nova Scotia and the Bay of Fundy) had been previously observed in the Gulf of Maine region. The sighting histories of the 14 Scotian Shelf whales matched to the Gulf of Maine suggested that many of them were transient through the latter area. There were no matches between the Scotian Shelf and any North Atlantic feeding ground, except the Gulf of Maine; however, instructive comparisons are compromised by the often low sampling effort in other regions in recent years. Overall, while it is not possible to define the Gulf of Maine population by drawing a strict geographical boundary, it appears that the effective range of many members of this stock does not extend onto the Scotian Shelf. Further work on the Scotian Shelf was conducted in August 2002 and August 2003; this sampling extended further north and east as far as the Laurentian Channel, and the results are expected to further clarify the issue of stock identity from this region. The very low match rate between the two sampled years (only one animal was resighted in the region in both 1998 and 1999) suggests that the Scotian Shelf is host to a larger population of humpback whales than was previously thought. However, preliminary analysis of photographs collected in 2002 and 2003 revealed a number of inter-annual matches; it is not yet clear whether a suitably precise abundance estimate can be calculated from these data.

In winter, whales from all feeding areas (including the Gulf of Maine) mate and calve primarily in the West Indies, where spatial and genetic mixing among subpopulations occurs (Clapham et al. 1993; Katona and Beard 1990; Palsbøll et al. 1997; Stevick et al. 1998). A few whales of unknown northern origin migrate to the Cape Verde Islands

(Reiner et al., 1996). In the West Indies, the majority of whales are found in the waters of the Dominican Republic, notably on Silver Bank, on Navidad Bank, and in Samana Bay (Balcomb and Nichols 1982; Whitehead and Moore 1982; Mattila et al. 1989, 1994). Humpback whales are also found at much lower densities throughout the remainder of the Antillean arc, from Puerto Rico to the coast of Venezuela (Winn et al. 1975; Levenson and Leapley 1978; Price 1985; Mattila and Clapham 1989).

It is apparent that not all whales migrate to the West Indies every winter, and that significant numbers of animals are found in mid- and high-latitude regions at this time (Clapham et al. 1993; Swingle et al. 1993). An increased number of sightings of humpback whales in the vicinity of the Chesapeake and Delaware Bays occurred in 1992 (Swingle et al. 1993). Wiley et al. (1995) reported 38 humpback whale strandings which occurred during 1985-1992 in the U.S. mid-Atlantic and southeastern states. Humpback whale strandings increased, particularly along the Virginia and North Carolina coasts, and most stranded animals were sexually immature; in addition, the small size of many of these whales strongly suggested that they had only recently separated from their mothers. Wiley et al. (1995) concluded that these areas are becoming an increasingly important habitat for juvenile humpback whales and that anthropogenic factors may negatively impact whales in this area. There have also been a number of wintertime humpback sightings in coastal waters of the southeastern U.S. (NMFS unpublished data; New England Aquarium unpublished data; Florida DEP unpublished data). Whether the increased sightings represent a distributional change, or are simply due to an increase in sighting effort and/or whale abundance, is presently unknown.

A key question with regard to humpback whales off the southeastern and mid-Atlantic states is their population identity. This topic was recently investigated using fluke photographs of living and dead whales observed in the region (Barco et al. 2002). In this study, photographs of 40 whales (live or dead) were of sufficient quality to be compared to catalogues from the Gulf of Maine (the closest feeding ground) and other areas in the North Atlantic. Of 21 live whales, 9 (42.9%) matched to the Gulf of Maine, 4 (19.0%) to Newfoundland and 1 (4.8%) to the Gulf of St Lawrence. Of 19 dead humpbacks, 6 (31.6%) were known Gulf of Maine whales. Although the population composition of the mid-Atlantic is apparently dominated by Gulf of Maine whales, lack of recent photographic effort in Newfoundland makes it likely that the observed match rates under-represent the true presence of Canadian whales in the region. Barco et al. (2002) suggested that the mid-Atlantic region primarily represents a supplemental winter feeding ground that is used by humpbacks for more than one purpose.

Feeding is the principal activity of humpback whales in New England waters, and their distribution in this region has been largely correlated to prey species and abundance, although behavior and bottom topography are factors in foraging strategy (Payne et al. 1986, 1990). Humpback whales are frequently piscivorus when in these waters, feeding on herring (*Clupea harengus*), sand lance (*Ammodytes* spp.), and other small fishes. In the northern Gulf of Maine, euphausiids are also frequently taken (Paquet et al. 1997). Commercial depletion of herring and mackerel led to an increase in sand lance in the southwestern Gulf of Maine in the mid 1970's with a concurrent decrease in humpback whale abundance in the northern Gulf of Maine. Humpback whales were densest over the sandy shoals in the southwestern Gulf of Maine favored by the sand lance during much of the late 1970's and early 1980's, and humpback distribution appeared to have shifted to this area (Payne et al. 1986). An apparent reversal began in the mid 1980's, and herring and mackerel increased as sand lance again decreased (Fogarty et al. 1991). Humpback whale abundance in the northern Gulf of Maine increased dramatically during 1992-1993, along with a major influx of herring (P. Stevick, pers. comm.). Humpback whales were few in nearshore Massachusetts waters in the 1992-1993 summer seasons. They were more abundant in the offshore waters of Cultivator Shoal and the Northeast Peak on Georges Bank, and on Jeffreys Ledge; these latter areas are more traditional locations of herring occurrence. In 1996 and 1997, sand lance, and thus humpback whales, were once again abundant in the Stellwagen Bank area. However, unlike previous cycles, where an increase in sand lance corresponded to a decrease in herring, herring remained relatively abundant in the northern Gulf of Maine, and humpbacks correspondingly continued to occupy this portion of the habitat, where they also fed on euphausiids (unpublished data, Center for Coastal Studies and College of the Atlantic).

In early 1992, a major research initiative known as the Years of the North Atlantic Humpback (YONAH) (Smith et al. 1999) was initiated. This project was a large-scale, intensive study of humpback whales throughout almost their entire North Atlantic range, from the West Indies to the Arctic. During two primary years of field work, photographs for individual identification and biopsy samples for genetic analysis were collected from summer feeding areas and from the breeding grounds in the West Indies. Additional samples were collected from certain areas in other years. Results pertaining to the estimation of abundance and to genetic population structure are summarized below.

POPULATION SIZE

The overall North Atlantic population (including the Gulf of Maine) was estimated from genetic tagging data collected by the YONAH project in the breeding range at 4,894 males (95% CI=3,374-7,123) and 2,804 females (95% CI=1,776-4,463) (Palsbøll et al. 1997). Since the sex ratio in this population is known to be even (Palsbøll et al. 1997), the excess of males is presumed to be a result of sampling bias, lower rates of migration among females or sex-specific habitat partitioning in the West Indies; whatever the reason, the combined total is an underestimate of overall population size in this ocean. Photographic mark-recapture analyses from the YONAH project gave an ocean-basin-wide estimate of 11,570 for 1992/1993 (CV=0.068, Stevick et al. 2003), and an additional genotype-based analysis yielded a similar but less precise estimate of 10,400 (95% CI=8,000 to 13,600) (Smith et al. 1999). The estimate of 11,570 (CV=0.068) is regarded as the best available estimate for the North Atlantic, although because YONAH sampling was not spatially representative in the feeding grounds, this figure is negatively biased. In the northeastern North Atlantic, Øien (2001) estimated from sighting survey data that there were 889 (CV=0.32) humpback whales in the Barents and Norwegian Seas region.

Estimating abundance for the Gulf of Maine stock has proved problematic. Three approaches have been investigated: mark-recapture estimates, minimum population size, and line-transect estimates. Most of the mark-recapture estimates were affected by heterogeneity of sampling, which was heavily focused on the southwestern Gulf of Maine. However, an estimate of 652 (CV=0.29) derived from the more extensive and representative YONAH sampling in 1992 and 1993 was probably less subject to this bias.

The second approach uses photo-identification data to establish the minimum number of humpback whales known to be alive in a particular year, 1997. By determining the number of identified individuals seen either in that year, or in both a previous and subsequent year, it is possible to determine that at least 497 humpbacks were alive in 1997. This figure is also likely to be negatively biased, again because of heterogeneity of sampling. A similar calculation for 1992 (which would correspond to the YONAH estimate for the Gulf of Maine) yields a figure of 501 whales.

In the third approach, data were used from a 28 July to 31 August 1999 line-transect sighting survey conducted by a ship and airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence. Total track line length was 8,212km. However, in light of the information on stock identity of Scotian Shelf humpback whales noted above, only the portions of the survey covering the Gulf of Maine were used; surveys blocks along the eastern coast of Nova Scotia were excluded. Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)* (Palka 2000). These surveys yielded an estimate of 816 humpbacks (CV=0.45). However, given that the rate of exchange between the Gulf of Maine and both the Scotian Shelf and mid-Atlantic region is not zero, this estimate is likely to be somewhat conservative. Accordingly, inclusion of data from 25% of the Scotian Shelf survey area (to reflect the match rate of 25% between the Scotian Shelf and the Gulf of Maine) gives an estimate of 902 whales (CV=0.41). Since the mark-recapture figures for abundance and minimum population size given above falls above the lower bound of the CV of the line transect estimate, and given the known exchange between the Gulf of Maine and the Scotian Shelf, we have chosen to use the latter as the best estimate of abundance for Gulf of Maine humpback whales.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for Gulf of Maine humpback whales is 902 (CV=0.41). The minimum population estimate for this stock is 647.

Table 1. Summary of abundance estimates for Gulf of Maine humpback whales. CCS = Center for Coastal Studies. COA = College of the Atlantic.

Month/Year	Type	N	CV	Source
1992/93	Mark-recapture estimate	652	0.29	Clapham *et al.* (2003)
1997	Minimum known to be alive	497	-	CCS + COA data
July/August 1999	Line transect, including a portion of the Scotian Shelf stratum	902	0.41	Palka 2000, Clapham *et al.* 2003

Current Population Trend

As detailed below, current data suggest that the Gulf of Maine humpback whale stock is steadily increasing in size. This is consistent with an estimated average trend of 3.1% (SE=0.005) in the North Atlantic population overall for the period 1979-1993 (Stevick et al. 2003), although there are no other feeding-area-specific estimates.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Barlow and Clapham (1997) applied an interbirth interval model to photographic mark-recapture data and estimated the population growth rate of the Gulf of Maine humpback whale stock at 6.5% (CV=0.012). Maximum net productivity is unknown for this population, although a theoretical maximum for any humpback population can be calculated using known values for biological parameters (Brandão et al. 2000; Clapham et al. 2001). For the Gulf of Maine, data supplied by Barlow and Clapham (1997) and Clapham et al. (1995) gives values of 0.96 for survival rate, 6 years as mean age at first parturition, 0.5 as the proportion of females, and 0.42 for annual pregnancy rate. From this, a maximum population growth rate of 0.072 is obtained according to the method described by Brandão et al. (2000). This suggests that the observed rate of 6.5% (Barlow and Clapham 1997) was close to the maximum for this stock.

Clapham et al. (2003) updated the Barlow and Clapham (1997) analysis using data from the period 1992 to 2000. The estimate was either 0% (for a calf survival rate of 0.51) or 4.0% (for a calf survival rate of 0.875). Although confidence limits are not available (because maturation parameters could not be estimated), both estimates of population growth rate are outside the 95% confidence intervals of the previous estimate of 6.5% for the period 1979 to 1991 (Barlow and Clapham 1997). It is unclear whether this apparent decline is an artifact resulting from a shift in distribution; indeed, such a shift occurred during exactly the period (1992-1995) in which survival rates declined. It is possible that this shift resulted in calves born in those years imprinting on (and thus subsequently returning to) areas other than those in which intensive sampling occurs. If the decline is a real phenomenon it may be related to known high mortality among young-of-the-year whales in the waters of the U.S. mid-Atlantic states. However, calf survival appears to have increased since 1996, presumably accompanied by an increase in population growth.

In light of the uncertainty accompanying the more recent estimate of population growth rate for the Gulf of Maine, for purposes of this assessment the maximum net productivity rate was assumed to be the default value for cetaceans of 0.04 (Barlow et al. 1995).

Current and maximum net productivity rates are unknown for the North Atlantic population overall. As noted above, Stevick et al. (2003) calculated an average population growth rate of 3.1% (SE=0.005) for the period 1979-1993.

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 647. The maximum productivity rate is the default value of 0.04. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because this stock is listed as an endangered species under the Endangered Species Act (ESA). PBR for the Gulf of Maine humpback whale stock is 1.3 whales.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1999 through 2003, the total estimated human-caused mortality and serious injury to the Gulf of Maine humpback whale stock is estimated as 3.6 per year (U.S. waters, 2.06; Canadian waters, 0.6; St. Vincent and the Grenadines, 0.4). This average is derived from three components: 1) incidental fishery interaction records, 2.26 (U.S. waters, 2.0; Canadian waters, 0.6); 2) records of vessel collisions, 0.46 (U.S. waters, 0.46; Canadian waters, 0), and directed takes from the Bequian harvest in St. Vincent and the Grenadines (0.4). There were additional humpback mortalities and serious injuries that occurred in the southeastern and mid-Atlantic states that could not be confirmed as involving members of the Gulf of Maine stock. These records represent an additional minimum annual average of 1.8 human-caused mortalities and serious injuries to humpbacks over the time period, of which 1.22 per year are attributable to incidental fishery interactions and 0.46 per year are attributable to vessel collisions.

Beginning with the 2001 Stock Assessment Report, Canadian records were incorporated into the mortality and serious injury rates, to reflect the effective range of this stock as described above. In addition, records from the southeastern and mid-Atlantic states involving individuals that could not be identified as members of the Gulf of Maine stock were tallied separately. Conversely, records involving unidentified individuals reported between New York and the Bay of Fundy were assumed to be whales from the Gulf of Maine stock. It is also important to stress that serious injury determinations are made based upon the best available information at the time of writing; these determinations may change with the availability of new information. For the purposes of this report, discussion is primarily limited to those records considered confirmed human-caused mortalities or serious injuries.

To better assess human impacts (both vessel collision and gear entanglement), and considering the number of decomposed and incompletely or unexamined animals in the records, there needs to be greater emphasis on the timely recovery of carcasses and complete necropsies. The literature and review of records described here suggest that there are significant human impacts beyond those recorded in the fishery observer data. For example, a study of entanglement-related scarring on the caudal peduncle of 134 individual humpback whales in the Gulf of Maine suggested that between 48% and 65% had experienced entanglements (Robbins and Mattila 2001). Decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or necropsied) represent 'lost data', some of which may relate to human impacts.

"Serious injury" was defined in 50 CFR part 229.2 as an injury that was likely to lead to mortality. We therefore limited the serious injury designation to only those reports that had substantiated evidence that the injury, whether from entanglement or vessel collision, was likely to lead to the whale's death. Determinations of serious injury were made on a case by case basis following recommendations from the workshop conducted in 1997 on differentiating serious and non-serious injuries (Angliss and DeMaster 1998). Injuries that impeded the whale's locomotion or feeding were not considered serious injuries unless they were likely to be fatal in the foreseeable future. There was no forecasting of how the entanglement or injury may increase the whale's susceptibility to further injury, namely from additional entanglements or vessel collisions. For these reasons, the human impacts listed in this report are a minimum estimate.

Background

As with right whales, human impacts (vessel collisions and entanglements) are factors which may be slowing recovery of the humpback whale population. There is an average of 4 to 6 entanglements of humpback whales a year in waters of the southern Gulf of Maine and additional reports of vessel-collision scars (unpublished data, Center for Coastal Studies). Of 20 dead humpback whales (principally in the mid-Atlantic, where decomposition did not preclude examination for human impacts), Wiley et al. (1995) reported that 6 (30%) had major injuries possibly attributable to ship strikes, and 5 (25%) had injuries consistent with possible entanglement in fishing gear. One whale displayed scars that may have been caused by both ship strike and entanglement. Thus, 60% of the whale carcasses which were suitable for examination showed signs that anthropogenic factors may have contributed to, or been responsible for, their death. Wiley et al. (1995) further reported that all stranded animals were sexually immature, suggesting a winter or migratory segregation and/or that juvenile animals are more susceptible to human impacts.

An updated analysis of humpback whale mortalities from the mid-Atlantic states region has recently been produced by Barco et al. (2002). Between 1990 and 2000, there were 52 known humpback whale mortalities in the waters of the U.S. mid-Atlantic states. Length data from 48 of these whales (18 females, 22 males and 8 of unknown sex) suggested that 39 (81.2%) were first-year animals, 7 (14.6%) were immature and 2 (4.2%) were adults. However, sighting histories of 5 of the dead whales indicate that some were small for their age, and histories of live whales further indicate that the population contains a greater percentage of mature animals than is suggested by the stranded sample.

In their study of entanglement rates estimated from caudal peduncle scars, Robbins and Mattila (2001) found that males were more likely to be entangled than females. The scarring data also suggested that yearlings were more likely than other age classes to be involved in entanglements. Finally, female humpbacks showing evidence of prior entanglements produced significantly fewer calves, suggesting that entanglement may significantly impact reproductive success.

Humpback whale entanglements also occur in relatively high numbers in Canadian waters. Reports of collisions with fixed fishing gear set for groundfish around Newfoundland averaged 365 annually from 1979 to 1987 (range 174-813). An average of 50 humpback whale entanglements (range 26-66) was reported annually between 1979 and 1988, and 12 of 66 humpback whales that were entangled in 1988 died (Lien et al. 1988). Volgenau et al. (1995) also summarized existing data and concluded that in Newfoundland and Labrador, cod traps caused the most entanglements and entanglement mortalities (21%) of humpbacks between 1979 and 1992. They also reported that gillnets are the gear that has been the primary cause of entanglements and entanglement mortalities (20%) of humpbacks in the Gulf of Maine between 1975 and 1990.

Disturbance by whale watching may prove to be an important habitat issue in some areas of this population's range, notably the coastal waters of New England where the density of whale watching traffic is seasonally high. No studies have been conducted to address this question, and its impact (if any) on habitat occupancy and reproductive success is unknown.

Fishery-Related Serious Injuries and Mortalities

A description of Fisheries is provided in Appendix III. Two mortalities were observed in the pelagic drift gillnet fishery since 1989. In winter 1993, a juvenile humpback was observed entangled and dead in a pelagic drift gillnet along the 200m isobath northeast of Cape Hatteras; in early summer 1995, a humpback was entangled and dead in a pelagic drift gillnet on southwestern Georges Bank. Additional reports of mortality and serious injury relevant to comparison to PBR, as well as description of total human impacts, are contained in records maintained by NMFS. A number of these records (11 entanglements involving lobster pot/trap gear) from the 1990-1994 period were cause to reclassify the lobster fishery (62 FR 33, Jan. 2, 1997).

For this report, the records of dead, injured, and/or entangled humpbacks (found either stranded or at sea) for the period 1999 through 2003 were reviewed. Out of 106173 records, 85148 were eliminated from further consideration due to an absence of any evidence of human impact or, in the case of an entangled whale, it was documented that the animal had become disentangled (10 were disentangled in 2003 alone). Of the remaining records, the Gulf of Maine stock sustained 34 mortalities attributable to fishery interactions and 89 cases of serious injuries — 1113 records in the five-year period (Table 2). In addition, 43 mortalities and 23 serious injuries were documented in the southeastern and mid-Atlantic states that involved interactions with fisheries. At the time of this writing, no genetic results were available to identify which of these cases may have involved whales from the Gulf of Maine stock. While these records are not statistically quantifiable in the same way as the observed fishery records, they provide some indication of the frequency of entanglements.

Table 2. Summarized records of mortality and serious injury likely to result in mortality, for North Atlantic humpback whales, January 1999 - December 2003. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFSNMFS. Records counted as from the Gulf of Maine humpback whale stock are indicated by an asterisk (*) following the date. Stock identification of the remaining records are awaiting genetic analysis results. These may identify additional Gulf of Maine whales.

Date	Report Type	Sex, age, ID length	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh.inter	
1/12/99*	mortality	9.7m male	Martha's Vineyard, MA		P	Fresh and extensive rope marks on carcass with associated hemorrhaging

Date	Report Type	Sex, age, ID length	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh.inter	
3/6/99*	mortality	13.8m female and calf	Bequia, St. Vincent and the Grenadines			Two whales taken by the Bequian harpoon fishery
8/2/99*	serious injury	9.4m estimated	Bay of Fundy, Canada		P	Single wrap of ½ inch poly line pinning flippers
9/23/99*	serious injury	unknown	off Chatham, MA		P	Line out of mouth and several wraps around body; possibly anchored
1/8/00	serious injury	9.9m estimated	30mi east Cape Lookout, NC		P	whale swam off with 600' of sea trout sink gillnet, a chain anchor and a high flyer in tow
8/4/00*	serious injury	10.7m estimated	Bay of Fundy, Canada		P	gillnet wrapped on head with weighted trailing line giving tension
9/6/00*	serious injury	<1 yr old, calf of "Giraffe"	Stellwagen Bank, MA		P	single line wrapped across back; constriction will increase as whale grows
10/14/00	serious injury	9.9m estimated	off Ocean City Inlet, MD		P	Heavily entangled in line and netting; constrictive--fresh wounds noted
10/20/00*	serious injury	10 yr old male "Tribble"	Stellwagen Bank, MA		P	Entangled in green poly line on multiple body parts; appears constrictive
1/25/01	mortality	6.9m estimated	Avon, NC	P		extensive hemorrhaging along left thoracic, clean cut through center of vertebrae; ship strike
4/8/01	mortality	7.9m juvenile male	Myrtle Beach, SC	S	P	pre-mortem evidence of chronic line entanglement; severe prop wounds
4/8/01	mortality	7.6m juvenile male	Emerald Isle, NC		P	entanglement around peduncle caused extensive edema, hemorrhaging
4/9/01*	mortality	8.8m juvenile female "Inland"	offshore of Sandbridge, Virginia Beach		P	found anchored in gillnet gear; line wraps around rostrum had immobilized the whale

Date	Report Type	Sex, age, ID length	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh.inter	
7/29/01*	mortality	8.5m juvenile female	floating south of Verrazano Bridge, NY	P		large laceration on left side of head, extensive fracturing of skull
10/1/01*	mortality	11.4m 3 yr old female "Pitfall"	Duxbury Beach, MA	P		massive fracturing to skull, focal bruising indicative of pre-mortem ship strike
2/8/02	mortality	8.4m juvenile female	off Cape Henry, VA	P		three large lacerations, hemorrhaging, broken bones
3/24/02	mortality	8.0m juvenile male	off Virginia Beach, VA		P	deep cuts on caudal peduncle and tail indicative of embedded line
6/3/02*	mortality	9.9m	off Cape Elizabeth, ME		P	deep cuts on caudal peduncle indicative of embedded line
6/17/02*	serious injury	10.2m estimated	Cape Cod Bay, MA		P	fluke severely damaged by line, whale emaciated
8/1/02*	mortality	9.3m male	Long Island, NY	P		large hematoma posterior to blow holes
10/1/02*	mortality	7.5m female calf	Plymouth, MA		P	Found wrapped in lobster warp, extensive bruising
6/6/03	mortality	8.3m female	Chesapeake Bay mouth, VA	P		Major trauma to right side of head, hematoma
7/9/03*	serious injury	calf of Shockwave	Bay of Fundy, Canada		P	Constricting entanglement on a young whale
7/12/03	serious injury	unknown	Oregon Inlet, NC		P	Entangled in substantial amount of gear
8/16/03*	serious injury	unknown	off Cape Cod, MA		P	Poor body condition; line deeply embedded
8/18/03*	serious injury	unknown	off Cape Cod, MA		P	Extensive entanglement

Table notes:

1. The date sighted and location provided in the table are not necessarily when or where the serious injury or mortality occurred; rather, this information indicates when and where the whale was first reported beached, entangled, or injured.
2. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria

as established by NERO/NMFS (62 FR 33, Jan. 2, 1997) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.

3. Assigned cause based on best judgement of available data. Additional information may result in revisions.
4. Entanglements of juvenile whales may become more serious as the whale grows.

Other Mortality

Between November 1987 and January 1988, at least 14 humpback whales died after consuming Atlantic mackerel containing a dinoflagellate saxitoxin (Geraci et al. 1989). The whales subsequently stranded or were recovered in the vicinity of Cape Cod Bay and Nantucket Sound, and it is highly likely that other mortalities occurred during this event which went unrecorded. In July 2003, another Unusual Mortality Event was recorded in offshore waters when an estimated minimum of 12-15 humpback whales died in the vicinity of the Northeast Peak of Georges Bank. Preliminary tests of samples taken from some of these whales tested positive for domoic acid at low levels, but it is currently unknown what levels would affect the whales and therefore no definitive conclusions can yet be drawn regarding the cause of this event. Its effect on the status of the Gulf of Maine humpback whale population is currently unknown.

During the first six months of 1990, seven dead juvenile (7.6 to 9.1m long) humpback whales stranded between North Carolina and New Jersey. The significance of these strandings is unknown, but is a cause for some concern.

As reported by Wiley et al. (1995), injuries possibly attributable to ship strikes are more common and probably more serious than those from entanglements. In the NMFSNMFS records for 1999 through 2003, 1115 records had some evidence of a collision with a vessel. Of these, 6 were mortalities as a result of the collision, and 58 did not have sufficient information to confirm the collision as the cause of death. The remaining incident occurred on 10/4/01 and involved a whale-watch vessel. Photos taken at the time of the collision confirmed that the injury was minor and follow-up documentation provided evidence that the injury sustained had healed. Three out of the 6 cases of mortality from a vessel collision involved whaleswhales identified as membersmembers of the Gulf of Maine stock (7/29/017/29/01, 10/1/01 and 8/1/02; see Table 2).

On 6 March 1999, a 46-foot female and what was likely her calf (20-23 feet in length) were taken by the Bequian harvest in St. Vincent and the Grenadines. The larger whale was identified as a Gulf of Maine whale (J. Robbins, pers. comm.).

STATUS OF STOCK

The status of the North Atlantic humpback whale population was the topic of an International Whaling Commission Comprehensive Assessment in June 2001, and again in May 2002; these meetingsthese meetings conducted a detailed review of all aspects of this population (IWC 2002). Although the most recent estimates of abundance indicate continued population growth, the size of the humpback whale stock may be below OSP in the U.S. Atlantic EEZ. This is a strategic stock because the humpback whale is listed as an endangered species under the ESA. A Recovery Plan has been published and is in effect (NMFS 1991). There are insufficient data to reliably determine current population trends for humpback whales in the North Atlantic overall. The average annual rate of population increase was estimated at 3.1% (SE=0.005, Stevick et al. 2003). As noted above, a recent analysis of demographic parameters for the Gulf of Maine (Clapham et al. 2003) suggested a lower rate of increase than the 6.5% reported by Barlow and Clapham (1997), but results may have been confounded by distribution shifts. The total level of human-caused mortality and serious injury is unknown, but current data indicate that it is significant. In particular, the continued high level of mortality among humpback whales off the U.S. mid-Atlantic states (Barco et al. 2002 2002), is cause for considerable concern given that at least some of these animals are known to be from the Gulf of Maine. This is a strategic stock because the average annual fishery-related mortality and serious injury exceeds PBR, and because the North Atlantic humpback whale is an endangered species.

A new large-scale assessment called More of North Atlantic Humpbacks (MoNAH) project is currently underway. This two-year study will attempt to estimate abundance and refine knowledge of population structure with extensive sampling in the Gulf of Maine/Scotian Shelf region and on the primary wintering ground on Silver Bank; additional research will focus on the U.S. mid-Atlantic states. The work is intended to update the YONAH assessment of North Atlantic humpback whales in preparation for a possible status review under the Endangered Species Act.

REFERENCES

Angliss, R. P., and D. P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations: report of the serious injury workshop 1-2 April 1997, Silver Spring, Maryland. NOAA Technical Memorandum NMFS-OPR-13, January 1998.

Balcomb, K. C. and G. Nichols. 1982. Humpback whale censuses in the West Indies. *Rep. int. Whal. Commn.* 32: 401-406.

Barco, S., McLellan, W.A., Allen, J., Asmutis, R., Mallon-Day, R., Meagher, E., Pabst, D.A., Robbins, J., Seton, R., Swingle, R.M., Weinrich, M.T, and Clapham, P. 2002. Population identity of humpback whales in the waters of the U.S. mid-Atlantic states. *J. Cetacean Res. Manage.* 4: 135-141.

Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. *Ecology* 78: 535-546.

Brandão, A., D. S. Butterworth and M.R. Brown. 2000. Maximum possible humpback whale increase rates as a function of biological parameter values. *J. Cetacean Res. Manage.* 2 (supplement): 192-193.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the USA outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Christensen, I., T. Haug, and N. Øien. 1992. Seasonal distribution, exploitation and present abundance of stocks of large baleen whales (Mysticeti) and sperm whales (*Physeter macrocephalus*) in Norwegian and adjacent waters. *ICES J. Mar. Sci.* 49: 341-355.

Clapham, P. J. and C. A. Mayo. 1987. Reproduction and recruitment of individually identified humpback whales, *Megaptera novaeangliae*, observed in Massachusetts Bay, 1979-1985. *Can. J. Zool.* 65: 2853-2863.

Clapham, P. J. and C. A. Mayo. 1990. Reproduction of humpback whales (*Megaptera novaeangliae*) observed in the Gulf of Maine. *Rep. int. Whal. Commn.* Special Issue 12: 171-175.

Clapham, P. J. 1992. Age at attainment of sexual maturity in humpback whales, *Megaptera novaeangliae*. *Can. J. Zool*. 70: 1470-1472.

Clapham, P. J., L. S. Baraff, C. A. Carlson, M. A. Christian, D. K. Mattila, C. A. Mayo, M. A. Murphy, and S. Pittman. 1993. Seasonal occurrence and annual return of humpback whales, *Megaptera novaeangliae*, in the southern Gulf of Maine. *Can. J. Zool*. 71: 440-443.

Clapham, P.J., Bérubé, M.C. & Mattila, D.K. 1995. Sex ratio of the Gulf of Maine humpback whale population. *Mar. Mammal Sci.* 11: 227-231.

Clapham, P.J., Barlow, J., Cole, T., Mattila, D., Pace, R., Palka, D.. Robbins, J. and Seton, R. 20022003. Stock definition, abundance and demographic parameters of humpback whales from the Gulf of Maine. *J. Cetacean Res. Manage.* 5: 13-22.

Clapham, P.J., Robbins, J., Brown, M., Wade, P. and Findlay, K. 20012001. A note on plausible rates of population growth for humpback whales. *J. Cetacean Res. Manage.* 3 (suppl.): 196-197.

Fogarty, M. J., E. B. Cohen, W. L. Michaels, and W. W. Morse. 1991. Predation and the regulation of sand lance populations: An exploratory analysis. *ICES Mar. Sci. Symp*. 193: 120-124.

Geraci, J. R., D. M. Anderson., R. J. Timperi, D. J. St. Aubin., G. A. Early, J. H. Prescott and C. A. Mayo. 1989 Humpback whales (*Megaptera novaeangliae*) fatally poisoned by dinoflagellate toxins. *Can. J. Fish. Aquat. Sci*. 46: 1895-1898.

IWC. 2002. Report of the Scientific Committee. Annex H: Report of the Sub-committee on the Comprehensive Assessment of North Atlantic humpback whales. *J. Cetacean Res. Manage.* 3 (supplement) (in press).

Katona, S. K., and J. A. Beard. 1990. Population size, migrations, and feeding aggregations of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic ocean. *Rep. int. Whal. Commn*. Special Issue 12: 295-306.

Katona, S. K., J. M. Allen, and P. Stevick. 1994. Maintaining the North Atlantic humpback whale catalog. Progress report to the Northeast Fisheries Science Center, Contract No. 50EANF-1-00056, May 1994, 26 pp. Available from: NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543.

Larsen, A. H., J. Sigurjónsson, N. Øien, G. Vikingsson, and P. J. Palsbøll. 1996. Population genetic analysis of mitochondrial and nuclear genetic loci in skin biopsies collected from central and northeastern North Atlantic humpback whales (*Megaptera novaeangliae*): population identity and migratory destinations. *Proceedings of the Royal Society of London* B 263: 1611-1618.

Levenson, C. and Leapley, W.T. 1978. Distribution of humpback whales (*Megaptera novaeangliae*) in the

Caribbean determined by a rapid acoustic method. *J. Fish. Res. Bd. Can.* 35: 1150-1152.

Lien, J., W. Ledwell, and J. Naven. 1988. Incidental entrapment in inshore fishing gear during 1988: A preliminary report to the Newfoundland and Labrador Department of Fisheries and Oceans, 15 pp.

Mattila, D. K. and P. J. Clapham. 1989. Humpback whales and other cetaceans on Virgin Bank and in the northern Leeward Islands, 1985 and 1986. *Can. J. Zool.* 67: 2201-2211.

Mattila, D. K., P. J. Clapham, S. K. Katona and G. S. Stone. 1989. Population composition of humpback whales on Silver Bank. *Can. J. Zool.* 67: 281-285.

Mattila, D.K., Clapham, P.J., Vásquez, O. & Bowman, R. 1994. Occurrence, population composition and habitat use of humpback whales in Samana Bay, Dominican Republic. *Canadian Journal of Zoology* 72: 1898-1907.

NMFS. 1991. Recovery plan for the humpback whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, MD, 105 pp.

Northridge, S. 1996. Estimation of cetacean mortality in the USA Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Report to the Northeast Fisheries Science Center, Contract No. 40ENNF500160. 21p. Available from: NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543.

Øien, N. 1990. Sighting surveys in the northeast Atlantic in July 1988: distribution and abundance of cetaceans. *Rep. int. Whal. Commn*. 40: 499-511.

Øien, N. 2001. Humpback whales in the Barents and Norwegian Seas. Paper SC/53/NAH21 presented to the International Whaling Commission Scientific Committee. Available from IWC, 135 Station Road, Impington, Cambridge, UK.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. *Rep. int Whal. Commn.* (special issue) 16: 27-50.

Palka, D. 2000. Abundance of the Gulf of Maine/Bay of Fundy harbor porpoise based on shipboard and aerial surveys during 1999. NMFS, Northeast Fisheries Science Center Ref. Doc. 00-07; 29 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543.

Paquet, D., C. Haycock and H. Whitehead. 1997. Numbers and seasonal occurrence of humpback whales (*Megaptera novaeangliae*) off Brier Island, Nova Scotia. *Can. Field Nat.* 111: 548-552.

Palsbøll, P. J., J. Allen,, M. Bérubé, P. J. Clapham, T. P. Feddersen, P. Hammond, H. Jørgensen, S. Katona, A. H. Larsen, F. Larsen, J. Lien, D. K. Mattila, J. Sigurjónsson, R. Sears, T. Smith, R. Sponer, P. Stevick and N. Øien. 1997. Genetic tagging of humpback whales. *Nature* 388: 767-769.

Palsbøll, P.J., P. J. Clapham, D. K. Mattila, F. Larsen, R. Sears, H. R. Siegismund, J. Sigurjónsson, O. Vásquez and P. Arctander. 1995. Distribution of mtDNA haplotypes in North Atlantic humpback whales: the influence of behavior on population structure. *Marine Ecology Progress Series* 116: 1-10.

Palsbøll, P.J., Allen, J. Anderson, T.H., Bérubé, M., Clapham, P.J., Feddersen, T.P., Friday, N., Hammond, P., Jørgensen, H., Katona, S.K., Larsen, A.H., Larsen, F., Lien, J., Mattila, D.K., Nygaard, F.B., Robbins, J., Sponer, R., Sears, R., Sigurjónsson, J., Smith, T.D., Stevick, P.T., Vikingsson, G. and Øien, N. 2001. Stock structure and composition of the North Atlantic humpback whale, *Megaptera novaeangliae*. Paper SC/53/NAH11 presented to the International Whaling Commission Scientific Committee. Available from IWC, 135 Station Road, Impington, Cambridge, UK.

Payne, P. M., J. R. Nicholas, L. O'Brien, and K. D. Powers. 1986. The distribution of the humpback whale, *Megaptera novaeangliae*, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, *Ammodytes americanus*. *Fish. Bull., U.S.* 84: 271-277.

Payne, P. M., D. N. Wiley, S. B. Young, S. Pittman, P. J. Clapham, and J. W. Jossi. 1990. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. *Fish. Bull., U.S.* 88(4): 687-696.

Price, W. S. 1985. Whaling in the Caribbean: historical perspective and update. *Rep. int. Whal. Commn.* 35: 413-420.

Reiner, F., M. E. Dos Santos, and F. W. Wenzel. 1996. Cetaceans of the Cape Verde archipelago. *Mar. Mammal Sci.* 12: 434-443.

Robbins, J. and D.K. Mattila. 2001. Monitoring entanglements of humpback whales (*Megaptera novaeangliae*) in the Gulf of Maine on the basis of caudal peduncle scarring. Paper SC/53/NAH25 presented to the International Whaling Commission Scientific Committee. Available from IWC, 135 Station Road, Impington, Cambridge, UK.

Smith, T. D., J. Allen, P. J. Clapham, P. S. Hammond, S. Katona, F. Larsen, J. Lien, D. Mattila, P. J. Palsbøll, J. Sigurjónsson, P. T. Stevick and N. Øien. 1999. An ocean-basin-wide mark-recapture study of the North

Atlantic humpback whale (*Megaptera novaeangliae*). *Mar. Mammal Sci.* 15(1):1-32.

Stevick, P.T., Allen, J., Clapham, P.J., Friday, N., Katona, S.K., Larsen, F., Lien, J., Mattila, D.K., Palsbøll, P.J., Sigurjónsson, J., Smith, T.D., Øien, N. and Hammond, P.S. 2003. North Atlantic humpback whale abundance and rate of increase four decades after protection from whaling. *Marine Ecology Progress Series* 258: 263-273.

Stevick, P., N. Øien and D. K. Mattila. 1998. Migration of a humpback whale between Norway and the West Indies. *Mar. Mammal Sci.* 14: 162-166.

Swingle, W. M., S. G. Barco, T. D. Pitchford, W.A. McLellan and D.A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. *Mar. Mammal Sci.* 9: 309-315.

Volgenau, L., S. D. Kraus, and J. Lien. 1995. The impact of entanglements on two substocks of the western North Atlantic humpback whale, *Megaptera novaeangliae*. *Can. J. Zool.* 73: 1689-1698.

Wade, P. R., and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop, April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12. U.S. Dept. of Commerce, Washington, DC. 93 pp.

Waring, G. T., D.L. Palka, P. J. Clapham, S. Swartz, M. C. Rossman, T. V. N. Cole, K. D. Bisack and L. J. Hansen. 1999. U.S. Atlantic marine mammal stock assessment reports — 1998. NOAA Tech. Memo. NMFS-NE-116, 182 pp.

Whitehead, H. and M.J. Moore. 1982. Distribution and movements of West Indian humpback whales in winter. *Can. J. Zool.* 60: 2203-2211.

Wiley, D. N., R. A. Asmutis, T. D. Pitchford, and D. P. Gannon. 1995. Stranding and mortality of humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States, 1985-1992. *Fish. Bull., U.S.* 93: 196-205.

Winn, H. E., R. K. Edel and A. G. Taruski. 1975. Population estimate of the humpback whale (*Megaptera novaeangliae*) in the West Indies by visual and acoustic techniques. *J. Fish. Res. Bd. Can.* 32: 499-506.

NORTH ATLANTIC RIGHT WHALE (*Eubalaena glacialis*): Western Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Individuals of the western North Atlantic right whale population range from wintering and calving grounds in coastal waters of the southeastern United States to summer feeding and nursery grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf. Knowlton et al. (1992) reported several long-distance movements as far north as Newfoundland, the Labrador Basin, and southeast of Greenland; in addition, recent resightings of photographically identified individuals have been made off Iceland, arctic Norway and in the old Cape Farewell whaling ground east of Greenland. The Norwegian sighting (in September 1999) represents one of only two sightings this century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range matches indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described. Similarly, records from the Gulf of Mexico (Moore and Clark 1963, Schmidly et al. 1972) represent either geographic anomalies or a more extensive historic range beyond the sole known calving and wintering ground in the waters of the southeastern United States. Whatever the case, the location of most of the population is unknown during the winter. Offshore surveys flown off the coast of northeastern Florida and southeastern Georgia from 1996 to 2001 had 3 sightings in 1996, 1 in 1997, 13 in 1998, 6 in 1999, 11 in 2000 and 6 in 2001 (within each year, some were repeat sightings of previously recorded individuals). The frequency with which right whales occur in offshore waters in the southeastern U.S. remains unclear.

Research results to date suggest the existence of 6 major habitats or congregation areas for western North Atlantic right whales; these are the coastal waters of the southeastern United States, the Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf. However, movements within and between habitats may be more extensive than is sometimes thought. Results from satellite tags clearly indicate that sightings separated by perhaps two weeks should not necessarily be assumed to indicate a stationary or resident animal. Instead, telemetry data have shown rather lengthy and somewhat distant excursions, including into deep water off the continental shelf (Mate et al. 1997). Systematic surveys conducted for the first time off the coast of North Carolina in winter of 2001 and 2002 sighted 8 calves, suggesting the calving grounds may extend as far north as Cape Fear. Four of the calves were not sighted by surveys conducted further south. One of the cows photographed was new to researchers, having effectively eluded identification over the period of its maturation (McLellan et al. 2004). The Northeast Fisheries Science Center is conducting an extensive multi-year aerial survey program throughout the Gulf of Maine region; this program is intended to better establish the distribution of right whales, including inter-annual variability in their occurrence in previously poorly studied habitats.

New England waters are a primary feeding habitat for the right whale, which appears to feed primarily on copepods (largely of the genera *Calanus* and *Pseudocalanus*) in this area. Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall right whale habitats (Kenney et al. 1986, 1995). Acceptable surface copepod resources are limited to perhaps 3% of the region during the peak feeding season in Cape Cod and Massachusetts Bays (C. Mayo pers. comm.). While feeding in the coastal waters off Massachusetts has been better studied than in most areas, feeding by right whales has also been observed on the margins of Georges Bank, in the Gulf of Maine, in the Bay of Fundy, and over the Scotian Shelf. The characteristics of acceptable prey distribution in these areas are not well known. In addition, New England waters serve as a nursery for calves and perhaps also as a mating ground. NOAA Fisheries and Center for Coastal Studies aerial surveys in the spring of 1999, 2000, 2001 and 2002 found substantial numbers of right whales along the Northern Edge of Georges Bank, in Georges Basin, and in various locations in the Gulf of Maine including Cashes Ledge, Platts Bank and Wilkinson Basin. The predictability with which right whales occur in such locations remains unclear, and these new data highlight the need for more extensive surveys of habitats which have previously received minimal coverage.

Genetic analyses based upon direct sequencing of mitochondrial DNA (mtDNA) have identified five mtDNA haplotypes in the western North Atlantic population (Malik et al. 1999). Schaeff et al. (1997) compared the genetic variability of North Atlantic and southern right whales (*E. australis*), and found the former to be significantly less diverse, a finding broadly replicated from sequence data by Malik et al. (2000). These findings might be indicative of inbreeding in the population, but no definitive conclusion can be reached using current data. Additional work comparing modern and historic genetic population structure in right whales, using DNA extracted from museum and archaeological specimens of baleen and bone, is also underway (Rosenbaum et al. 1997, 2000). Preliminary results suggest that the eastern and western North Atlantic populations were not genetically distinct (Rosenbaum et al. 2000). However, the virtual extirpation of the eastern stock and its lack of recovery in the last hundred years strongly suggests population subdivision over a protracted (but not evolutionary) timescale. Results also suggest that, as expected, the principal loss of genetic diversity occurred during major exploitation events prior to the 20th century.

To date, skin biopsy sampling has resulted in the compilation of a DNA library of almost 300 North Atlantic right whales. When work is completed, a genetic profile will be established for each individual, and an assessment provided on the level of genetic variation in the population, the number of reproductively active individuals, reproductive fitness, the basis for associations and social units in each habitat area, and the mating system. Tissue analysis has also aided in sex identification: the sex ratio of the photo-identified and catalogued population does not differ significantly from parity. Analyses based on both genetics and sighting histories of photographically identified individuals also suggest that approximately one-third of the females with calves population utilizes summer feeding grounds other than the Bay of Fundy. As described above, a related question is where individuals other than calving females and a few juveniles overwinter. One or more additional wintering and summering grounds may exist in unsurveyed locations, although it is also possible that "missing" animals simply disperse over a wide area at these times. Identification of such areas, and the possible threats to right whales there, is recognized as a priority for research efforts.

POPULATION SIZE

Based on a census of individual whales identified using photo-identification techniques, the western North Atlantic population size was estimated to be 295 individuals in 1992 (Knowlton et al. 1994); an updated analysis using the same method gave an estimate of 291 animals in 1998 (Kraus et al. 2001) Because this was a nearly complete census, it is assumed that this represents a minimum population size estimate. However, no estimate of abundance with an associated coefficient of variation has been calculated for this population. Calculation of a reliable point estimate is likely to be difficult given the known problem of heterogeneity of distribution in this population. An IWC workshop on status and trends of western North Atlantic right whales gave a minimum direct-count estimate of 263 right whales alive in 1996 and noted that the true population was unlikely to be substantially greater than this (Best et al. 2001).

Historical Abundance

An estimate of pre-exploitation population size is not available. Basque whalers may have taken substantial numbers of right whales at times during the 1500's in the Strait of Belle Isle region (Aguilar 1986), and the stock of right whales may have already been substantially reduced by the time whaling was begun by colonists in the Plymouth area in the 1600's (Reeves and Mitchell 1987). A modest but persistent whaling effort along the coast of the eastern U.S. lasted three centuries, and the records include one report of 29 whales killed in Cape Cod Bay in a single day during January 1700. Based on incomplete historical whaling data, Reeves and Mitchell (1987) could conclude only that there were at least some hundreds of right whales present in the western North Atlantic during the late 1600's. In a later study (Reeves et al. 1992), a series of population trajectories using historical data and an estimated present population size of 350 were plotted. The results suggest that there may have been at least 1,000 right whales in this population during the early to mid-1600's, with the greatest population decline occurring in the early 1700's. The authors cautioned, however, that the record of removals is incomplete, the results were preliminary, and refinements are required. Based on back calculations using the present population size and growth rate, the population may have numbered fewer than 100 individuals by the time international protection for right whales came into effect in 1935 (Hain 1975, Reeves et al. 1992, Kenney et al. 1995). However, too little is known about the population dynamics of right whales in the intervening years to state anything with confidence.

Minimum Population Estimate

The western North Atlantic population size was estimated to be 291 individuals in 1998 (Kraus et al. 2001), based on a census of individual whales identified using photo-identification techniques. A bias that might result from including catalogued whales that had not been seen for an extended period of time and therefore might be dead, was addressed by assuming that an individual whale not sighted for five or more years was dead (Knowlton et al. 1994). It is assumed that the census of identified and presumed living whales represents a minimum population size estimate. The true population size in 1998 may have been higher if: 1) there were animals not photographed and identified, and/or 2) some animals presumed dead were not.

Current Population Trend

The population growth rate reported for the period 1986-1992 by Knowlton et al. (1994) was 2.5% (CV=0.12), suggesting that the stock was showing signs of slow recovery. However, work by Caswell et al. (1999) has suggested that crude survival probability declined from about 0.99 in the early 1980's to about 0.94 in the late 1990's. The decline was statistically significant. Additional work conducted in 1999 was reviewed by the IWC workshop on status and trends in this population (Best et al. 2001); the workshop concluded based on several analytical approaches that survival had indeed declined in the 1990's. Although heterogeneity of capture could negatively bias survival estimates, the workshop concluded that this factor could not account for all of the observed decline, which appeared to be particularly marked in adult females. Another workshop was convened by NOAA Fisheries in September 2002, and after reviewing several approaches to survival estimation reached similar conclusions regarding the decline in this population (Clapham 2002).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

During 1980-1992, 145 calves were born to 65 identified cows. The number of calves born annually ranged from 5 to 17, with a mean of 11.2 (SE=0.90). The reproductively active female pool was static at approximately 51 individuals during 1987-1992. Mean calving interval, based on 86 records, was 3.67 years. There was an indication that calving intervals may have been increasing over time, although the trend was not statistically significant (P=0.083) (Knowlton et al. 1994).

Since that report, total reported calf production in 92/93 was 8; 93/94, 9; 94/95, 7; 95/96, 24; 96/97, 20; 97/98, 6; 98/99, 4; 99/00, 1; 00/01, 31; 01/02, 24; and 02/03, 19 [mean 13.6 SE=2.9)]. However, this total calf production should be reduced by reported calf mortalities: 2 mortalities in 1993, 3 in 1996, 1 in 1997, 1 in 1998, 4 in 2001 and 2 in 2002. During 2002, 2 mortalities and 1 serious injury involved what were likely calves from 00/01. Of the three calf mortalities in 1996, available data suggested one was not included in the reported 24 mother/calf pairs, resulting in a total of 25 calves born. Eleven of the 21 mothers in 1996 were observed with calves for the first time (i.e., were “new” mothers) that year. Three of these were at least 10 years old, 2 were 9 years old, and 6 were of unknown age. An updated analysis of calving interval through the 1997/1998 season suggests that mean calving interval increased since 1992 from 3.67 years to more than 5 years, a significant trend (Kraus et al. 2001). This conclusion is supported by modeling work reviewed by the IWC workshop on status and trends in this population (Best et al. 2001); the workshop agreed that calving intervals had indeed increased and further that the reproductive rate was approximately half that reported from studied populations of *E. australis.* The low calf production in subsequent years (4 in 1999 and only 1 in 2000) gives added cause for concern, although a record 31 calves were born in 2001. A workshop on possible causes of reproductive failure was held in April 2000 (Reeves et al. 2001). Factors considered included contaminants, biotoxins, nutrition/food limitation, disease and inbreeding problems. While no conclusions were reached, a research plan to further investigate this topic was developed.

The annual population growth rate during 1986-1992 was estimated to be 2.5% (CV=0.12) using photo-identification techniques (Knowlton et al. 1994). A population increase rate of 3.8% was estimated from the annual increase in aerial sighting rates in the Great South Channel, 1979-1989 (Kenney et al. 1995). However, as noted above, more recent work indicated that the population was in decline in the 1990's (Caswell et al. 1999, Best et al. 2001).

An analysis of the age structure of this population suggests that it contains a smaller proportion of juvenile whales than expected (Hamilton et al. 1998a, Best et al. 2001), which may reflect lowered recruitment and/or high juvenile mortality. In addition, it is possible that the apparently low reproductive rate is due in part to unstable age structure or to reproductive senescence on the part of some females. However, data on either factor are poor; senescence has been demonstrated in relatively few mammals (including humans, pilot whales, and killer whales) and is currently undocumented for any baleen whale.

POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) is specified as the product of minimum population size, one-half the maximum net productivity rate and a "recovery" factor for endangered, depleted, threatened stocks, or stocks of unknown status relative to OSP (MMPA Sec. 3. 16 U.S.C. 1362, Wade and Angliss 1997). The recovery factor for right whales is 0.10 because this species is listed as endangered under the Endangered Species Act (ESA). However, in view of the population decline indicated by recent demographic analyses (Caswell et al. 1999, Best et al. 2001), the PBR for this population is set to zero.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1999 through 2003, the total estimated human-caused mortality and serious injury to right whales is estimated at 3.2 per year (U.S. waters, 2.0; Canadian waters, 1.2). This is derived from two components: 1) non-observed fishery entanglement records at 2.2 per year (U.S. waters, 1.4; Canadian waters, 0.8), and 2) ship strike records at 1.0 per year (U.S. waters, 0.8; Canadian waters, 0.2). Note that in the 1996 and 1998 stock assessment reports, a six-year time frame was used to calculate these averages. A five-year period has since been used to be consistent with the time frames used for calculating the averages for other species. Beginning with the 2001 Stock Assessment Report, Canadian records were incorporated into the mortality and serious injury rates of this report to reflect the effective range of this stock. It is also important to stress that serious injury determinations are made based upon the best available information; these determinations may change with the availability of new information. For the purposes of this report, discussion is primarily limited to those records considered confirmed human-caused mortalities or serious injuries.

Background

The details of a particular mortality or serious injury record often require a degree of interpretation. The assigned cause is based on the best judgment of the available data; additional information may result in revisions. When reviewing Table 1 below, several factors should be considered: 1) a ship strike or entanglement may occur at some distance from the reported location; 2) the mortality or injury may involve multiple factors; for example, whales that have been both ship struck and entangled are not uncommon; 3) the actual vessel or gear type/source is often uncertain; and 4) in entanglements, several types of gear may be involved.

The serious injury determinations are most susceptible to revision. There are several records where a struck and injured whale was re-sighted later, apparently healthy, or where an entangled or partially disentangled whale was re-sighted later free of gear. The reverse may also be true: a whale initially appearing in good condition after being struck or entangled is later re-sighted and found to have been seriously injured by the event. Entanglements of juvenile whales are typically considered serious injuries because the constriction on the animal is likely to become increasingly harmful as the whale grows.

"Serious injury" was defined in 50 CFR part 229.2 as an injury that was likely to lead to mortality. We therefore limited the serious injury designation to only those reports that had substantiated evidence that the injury, whether from entanglement or vessel collision, was likely to lead to the whale's death. Determinations of serious injury were made on a case by case basis following recommendations from the workshop conducted in 1997 on differentiating serious and non-serious injuries (Angliss and DeMaster 1998). Injuries that impeded the whale's locomotion or feeding were not considered serious injuries unless they were likely to be fatal in the foreseeable future. There was no forecasting of how the entanglement or injury may increase the whale's susceptibility to further injury, namely from additional entanglements or vessel collisions. This conservative approach likely underestimates serious injury rates.

With these caveats, the total estimated annual average human-induced mortality and serious injury incurred by this stock (including fishery and non-fishery related causes) was 3.2 right whales per year (U.S. waters 2.2; Canadian waters, 1.0). As with entanglements, some injury or mortality due to ship strikes almost certainly passes undetected, particularly in offshore waters. Decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or necropsied) represent 'lost data', some of which may relate to human impacts. For these reasons, the figure of 3.2 right whales per year must be regarded as a minimum estimate.

Further, the small population size and low annual reproductive rate suggest that human sources of mortality may have a greater effect relative to population growth rates than for other whales. The principal factors believed to be retarding growth and recovery of the population are ship strikes and entanglement with fishing gear. Between 1970 and 1999, a total of 45 right whale mortalities were recorded (IWC 1999, Knowlton and Kraus 2001). Of these, 13 (28.9%) were neonates that are believed to have died from perinatal complications or other natural causes. Of the remainder, 16 (35.6%) were determined to be the result of ship strikes, 3 (6.7%) were related to entanglement in fishing gear (in two cases lobster gear, and one gillnet gear), and 13 (28.9%) were of unknown cause. At a minimum, therefore, 42.2% of the observed total for the period, and 50% of the 32 non-calf deaths, were attributable to human impacts (calves accounted for three deaths from ship strike).

Young animals, ages 0-4 years, are apparently the most impacted portion of the population (Kraus 1990). Finally, entanglement or minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so that it is more likely to become vulnerable to further injury. Such was apparently the case with the two-year-old right whale killed by a ship off Amelia Island, Florida, in March 1991 after having carried gillnet gear wrapped around its tail region since the previous summer (Kenney and Kraus 1993). A similar fate befell right whale #2220, found dead on Cape Cod in 1996.

For waters of the northeastern USA, a present concern not yet completely defined, is the possibility of habitat degradation in Massachusetts and Cape Cod Bays due to a Boston sewage outfall, which came on-line in

September 2000.

Fishery-Related Serious Injury and Mortality

Reports of mortality and serious injury relative to PBR as well as total human impacts are contained in records maintained by the New England Aquarium and the NOAA Fisheries Northeast and Southeast Regional Offices (Table 1). From 1999 through 2003, 11 of 16 records of mortality or serious injury (including records from both USA and Canadian waters) involved entanglement or fishery interactions. The reports often do not contain the detail necessary to assign the entanglements to a particular fishery or location. Over time, however, additional sightings of entangled whales often provide the information needed.

Although disentanglement is either unsuccessful or not possible for the majority of cases, during the period 1999 through 2003, there were at least six documented cases of entanglements for which the intervention of disentanglement teams averted a likely serious injury determination. On 6/5/99, a two-year-old female, #2753, was found with a line through the mouth and trailing a Norwegian ball and highflyer. The nature of the entanglement would likely not have allowed the whale to shed the gear, and over a prolonged period, the rope's chafing likely would have caused systemic infection. Another two-year-old female, #2710, was sighted on 7/21/1999 wrapped in Canadian pot gear. A line passed through the mouth and around at least the right flipper. This entanglement would have become more constrictive as the whale grew. On 7/9/00, #2746, a three-year-old of unknown gender was seen with a line running through either side of the mouth and bridled behind the blowholes, while another portion of the line pinned the left flipper to the whale's flank. A nine-year-old female, #2223, was sighted on 8/18/00 with line tightly wrapped across her back, running through the mouth, and possibly wrapped on the left flipper. Subsequent sightings prior to the disentanglement revealed that the line across the back was beginning to tighten. On 7/20/01, #2427, a seven-year-old male was sighted off Portsmouth, New Hampshire, with line wrapped tightly around the rostrum and through the mouth. The whale was disentangled later that day, and subsequent resightings indicated that the injuries were healing. However, observers also noted that the whale's baleen was damaged, and that the whale was holding its head high out of the water and not diving nearly as frequently as other whales in the area. Lastly, an unidentified right whale was disentangled off Campobello Island, Canada on 7/09/03. The gear was tentatively identified as US lobster gear and other unknown gear.

In January 1997, NOAA Fisheries changed the classification of the Gulf of Maine and U.S. mid-Atlantic lobster pot fisheries from Category III to Category I based on examination of stranding and entanglement records of large whales from 1990 to 1994 (62 FR 33, Jan. 2, 1997).

Bycatch of a right whale has been observed by NOAA Fisheries Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in any of the other fisheries monitored by NOAA Fisheries. The only bycatch of a right whale documented by NOAA Fisheries Sea Samplers was a female released from a pelagic drift gillnet in 1993.

In a recent analysis of the scarification of right whales, a total of 61.6% of the whales bore evidence of entanglements with fishing gear (Hamilton et al. 1998b). Further research using the North Atlantic Right Whale Catalogue has indicated that, each year, between 10% and 28% of right whales are involved in entanglements (Knowlton et al. 2001). Entanglement records maintained by NOAA Fisheries Northeast Regional Office (NOAA Fisheries, unpublished data) from 1970 through 2000 included at least 72 right whale entanglements or possible entanglements, including right whales in weirs, entangled in gillnets, and trailing line and buoys. An additional record (M. J. Harris, pers. comm.) reported a 9.1-10.6m right whale entangled and released south of Ft. Pierce, Florida, in March 1982 (this event occurred during a sampling program and was not related to a commercial fishery). Incidents of entanglements in groundfish gillnet gear, cod traps, and herring weirs in waters of Atlantic Canada and the U.S. east coast were summarized by Read (1994). In 6 records of right whales becoming entangled in groundfish gillnet gear in the Bay of Fundy and Gulf of Maine between 1975 and 1990, the right whales were either released or escaped on their own, although several whales have been observed carrying net or line fragments. A right whale mother and calf were released alive from a herring weir in the Bay of Fundy in 1976. For all areas, specific details of right whale entanglement in fishing gear are often lacking. When direct or indirect mortality occurs, some carcasses come ashore and are subsequently examined, or are reported as "floaters" at sea; however, the number of unreported and unexamined carcasses is unknown, but may be significant in the case of floaters. More information is needed about fisheries interactions and where they occur.

Other Mortality

Ship strikes are a major cause of mortality and injury to right whales (Kraus 1990, Knowlton and Kraus 2001). Records from 1999 through 2003 have been summarized in Table 1. For this time frame, the average reported mortality and serious injury to right whales due to ship strikes was 1.0 whales per year (U.S. waters, 0.8; Canadian waters, 0.2). In 2004, two ships strike mortalities had been confirmed at the time of this writing. The first was found on 2/7/04 on Virginia Beach, VA, with major blunt trauma to the head and body. The second was reported struck by a troop transport ship off the Chesapaeke Bay entrance, and then seen again alive in the same area with a severed fluke on 11/17/04. It washed ashore dead on 11/24/04 in Ocean Sands, NC. Both of these events involved adult females carrying calves.

In 2000, two right whales were sighted in the Bay of Fundy with large open wounds that were likely the result of collisions with vessels. Right whale #2820, a male of unknown age, was first seen injured on 7/9/00. He was sighted intermittently throughout the remainder of that summer, and was seen again in the Bay of Fundy in 2001. The second whale, #2660, is a five-year-old female who was sighted with a wound on the left side of her head, just forward of the blowholes. She has not been resighted since. Although both of these injuries have a gruesome appearance, in the absence of a chronic stressor (i.e., entangling fishing gear), they are not likely to be fatal.

Table 1. Summarized records of mortality and serious injury likely to result in mortality, North Atlantic right whales, January 1999 through December 2003. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NOAA Fisheries.

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh inter	
4/20/99	mortality	27+ yr. old female #1014	Cape Cod, MA	P		Fractures to mandible and vertebral column, abrasion and edema around right flipper
5/10/99	mortality	Adult female #2030	80mi east of Cape Cod, MA		P	Constricting sink gillnet gear created deep, extensive lacerations
3/01/00	serious injury	Adult male #1130	6mi east of Manomet, MA		P	Line apparently constricting left flipper; flipper discolored; abnormal cyamid distribution; bullet buoy trailing, line weighted down between whale and buoy
3/17/01	mortality	Male calf	Assateague, VA	P		Large fresh propeller gashes on dorsal caudal and acute muscular hemorrhage
6/8/01	serious injury	Adult male #1102	58mi east of Cape Cod, MA		P	Entangling gear deeply embedded; whale showing numerous signs of poor health including emaciation, skin discoloration, and abnormal cyamid distribution
6/18/01	mortality	female calf	Long Island, NY	P		Dorsal propeller wounds, sub-dermal hemorrhage
11/3/01	mortality	Adult male #1238 14 m	Magdelen Islands, Canada		P	Thoroughly wrapped up in gear, whale seen alive and well five months earlier
2/12/02	serious injury	Adult male #1424	off Amelia Island, FL		P	multiple tight wraps around rostrum (last resighted 4/14/03)

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh inter	
4/7/02	serious injury	10.0m (est) #3120	off Cape Fear, NC		P	taunt line crossing back and left flipper, prolonged entanglement (last resighted 6/24/03)
7/6/02	mortality	11.0m (est) female #3107	off Briar Island, NS Canada		P	carcass ashore on Nantucket, MA; caudal peduncle severely lacerated where entangled
7/12/02	serious injury	Adult female #1427	off Long Beach Island, NJ		P	line tightly wrapped around rostrum
8/4/02	serious injury	Adult female #2320	Bay of Fundy, Canada		P	multiple wraps on rostrum, one tight (last resighted 4/29/03)
8/22/02	serious injury	Adult female #1815	Scotian Shelf, Canada		P	line tightly wrapped around head and tail stock
8/22/02	mortality	12.6m female 1±y.o.	off Ocean City, MD	P		large laceration on dorsal surface
8/30/02	serious injury	#3210 age & sex unknown	off Cape Cod, MA		P	line tightly wrapped around rostrum, resighted in 2004 in poor condition
10/02/03	mortality	Adult female #2150	off Digby, NS	P		Large fracture in skull, sub-dermal hemorrhage

STATUS OF STOCK

The size of this stock is considered to be extremely low relative to OSP in the U.S. Atlantic EEZ, and this species is listed as endangered under the ESA. The North Atlantic right whale is considered one of the most critically endangered populations of large whales in the world (Clapham et al. 1999). A Recovery Plan has been published and is in effect (NOAA Fisheries 1991), and a revised plan is under review. Three critical habitats, Cape Cod Bay/Massachusetts Bay, Great South Channel, and the Southeastern U.S., were designated by NOAA Fisheries (59 FR 28793, June 3, 1994). The NOAA Fisheries ESA 1996 Northern Right Whale Status Review concluded that the status of the western North Atlantic population of the northern right whale remains endangered [we note that 'northern right whale is an outdated classification and reference should be made to either north Atlantic or north Pacific right whales, two distinct species]; this conclusion was reinforced by the International Whaling Commission (Best et al. 2001), which expressed grave concern regarding the status of this stock. The total level of human-caused mortality and serious injury is unknown, but reported human-caused mortality and serious injury has been a minimum of 3.2 right whales per year from 1999 through 2003. Given that PBR has been set to zero, no mortality or serious injury for this stock can be considered insignificant. This is a strategic stock because the average annual fishery-related mortality and serious injury exceeds PBR, and because the North Atlantic right whale is an endangered species. Relative to populations of southern right whales, there are also concerns about growth rate, percentage of reproductive females, and calving intervals in this population.

REFERENCES

Aguilar, A. 1986. A review of old Basque whaling and its effect on the right whales of the North Atlantic. *Rep. int.*

Whal. Commn, Special Issue 10: 191-199.
Angliss, R. P., and D. P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations: report of the serious injury workshop 1-2 April 1997, Silver Spring, Maryland. NOAA Technical Memorandum NOAA Fisheries-OPR-13.
Best, P.B., Bannister, J.L., Brownell Jr., R.L., Donovan, G.P. (eds.) 2001. Right whales: worldwide status. *J. Cetacean Res. Manage.* (Special Issue) 2. 309pp.
Caswell, H., Brault, S. and Fujiwara, M. 1999. Declining survival probability threatens the North Atlantic right whale. *Proc. Natl. Acad. Sci. USA* 96: 3308-3313.
Clapham, P.J. (ed.) 2002. Report of the working group on survival estimation for North Atlantic right whales. Available from the Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543.
Clapham, P. J., S. B. Young and R. L. Brownell, Jr. 1999. Baleen whales: conservation issues and the status of the most endangered populations. *Mammal Review* 29: 35-60.
Hain, J. H. W. 1975. The international regulation of whaling. *Marine Affairs J.* 3: 28-48.
Hamilton, P. K., A. R. Knowlton, M. K. Marx and S. D. Kraus. 1998. Age structure and longevity in North Atlantic right whales *Eubalaena glacialis* and their relation to reproduction. *Marine Ecology Progress Series* 171: 285-292.
Hamilton, P. K., M. K. Marx, and S. D. Kraus. 1998. Scarification analysis of North Atlantic right whales (*Eubalaena glacialis*) as a method of assessing human impacts. Final report to the Northeast Fisheries Science Center, Contract No. 4EANF-6-0004.
IWC. 1999. Report of the workshop on the comprehensive assessment of right whales worldwide. *J. Cetacean Res. Manage.* 1 (supplement): 119-120.
Kenney, R. D., M. A. M. Hyman, R. E. Owen, G. P. Scott, and H. E. Won. 1986. Estimation of prey densities required by western North Atlantic right whales. *Mar. Mammal Sci.* 2(1): 1-13.
Kenney, R. D. and S. D. Kraus. 1993. Right whale mortality — a correction and an update. *Mar. Mammal Sci.* 9:445-446.
Kenney, R. D., H. E. Won, and M. C. Macaulay. 1995. Cetaceans in the Great South Channel, 1979-1989: right whale (*Eubalaena glacialis*). *Cont. Shelf Res.* 15: 385-414.
Knowlton, A. R., J. Sigurjonsson, J. N. Ciano, and S. D. Kraus. 1992. Long-distance movements of North Atlantic Right whales (*Eubalaena glacialis*). *Mar. Mammal Sci.* 8(4): 397-405.
Knowlton, A. R. and S. D. Kraus. 2001. Mortality and serious injury of North Atlantic right whales (*Eubalaena glacialis*) in the North Atlantic Ocean. *J. Cetacean Res. Manage.* (Special Issue) 2: 193-208.
Knowlton, A. R., S. D. Kraus, and R. D. Kenney. 1994. Reproduction in North Atlantic right whales (*Eubalaena glacialis*). *Can. J. Zool.* 72: 1297-1305.
Knowlton, A.R., M.K. Marx, H.M. Pettis, P.K. Hamilton and S.D. Kraus. 2001. Scarification analysis of North Atlantic right whales (*Eubalaena glacialis*): monitoring rates of entanglement interaction. Report to the National Marine Fisheries Service. Available from: New England Aquarium, Central Wharf, Boston, MA 02110.
Kraus, S. D. 1990. Rates and potential causes of mortality in North Atlantic right whales (*Eubalaena glacialis*). *Mar. Mammal Sci.* 6(4): 278-291.
Kraus, S. D., P. K. Hamilton, R. D. Kenney, A. Knowlton and C. K. Slay. 2001. Reproductive parameters of the North Atlantic right whale. *J. Cetacean Res. Manage.* (Special Issue) 2: 231-236.
Malik, S., M. W. Brown, S. D. Kraus, A. Knowlton, P. Hamilton and B. N. White. 1999. Assessment of genetic structuring and habitat philopatry in the North Atlantic right whale (*Eubalaena glacialis*). *Can. J. Zool.* 77: 1217-1222.
Malik, S., M. W. Brown, S. D. Kraus and B. N. White. 2000. Analysis of mitochondrial DNA diversity within and between North and South Atlantic right whales. *Mar. Mammal Sci.* 16: 545-558.
Mate, B. M., S. L. Nieukirk and S. D. Kraus. 1997. Satellite-monitored movements of the northern right whale. *J. Wildl. Manage.* 61: 1393-1405.
Mayo, C. A. and M .K. Marx. 1990. Surface foraging behaviour of the North Atlantic right whale, *Eubalaena glacialis*, and associated zooplankton characteristics. *Can. J. Zool.* 68: 2214-2220.
McLellan, W. A., E. Meagher, L. Torres, G. Lovewell, C. Harper, K. Irish, B. Pike, and A. D. Pabst. 2004. Winter right whale sightings from aerial surveys of the coastal waters of the US Mid-Atlantic. Presented at the 15th Biennial Conference on the Biology of Marine Mammals.
Moore, J. C. and E. Clark. 1963. Discovery of right whales in the Gulf of Mexico. *Science* 141(3577): 269.
NOAA Fisheries. 1991. Recovery plan for the northern right whale (*Eubalaena glacialis*). Prepared by the Right Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland, 86 pp.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn*., Special Issue 15: 133-147.

Reeves, R.R., R. Rolland, and P. Clapham (eds.). 2001. Report of the workshop on the causes of reproductive failure in North Atlantic right whales: new avenues of research. NOAA-NOAA Fisheries-NEFSC Ref. Doc. 01-16. 46p. Available from: NOAA Fisheries, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543.

Reeves, R. R. and E. Mitchell. 1987. Shore whaling for right whales in the northeastern United States. Contract Report No. NA85-WCC-06194, Southeast Fisheries Science Center, Miami, FL, 108 pp. Available from: NOAA Fisheries, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL, 33149.

Reeves, R. R., J. M. Breiwick and E. Mitchell. 1992. Pre-exploitation abundance of right whales off the eastern United States. Pages 5-7. *In*: J. Hain (ed.). *The right whale in the western North Atlantic: A science and management workshop, 14-15 April 1992, Silver Spring, Maryland*. NOAA-NOAA Fisheries-NEFSC Ref. Doc. No. 92-05. 88 pp. Available from: NOAA Fisheries, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543.

Rosenbaum, H. C., M. Egan, P. J. Clapham, R. L. Brownell Jr. and R. DeSalle. 1997. An effective method for isolating DNA from non-conventional museum specimens. *Mol. Ecol*. 6: 677-681.

Rosenbaum, H.C., Egan, M.S., Clapham, P.J., Brownell, R.L. Jr., Malik, S., Brown, M.W., White, B.N., Walsh, P. and DeSalle, R. 2000. Utility of North Atlantic right whale museum specimens for assessing changes in genetic diversity. *Conservation Biology* 14: 1837-1842.

Schaeff, C. M., S. D. Kraus, M. W. Brown, J. Perkins, R. Payne and B. N. White. 1997. Comparison of genetic variability of North and South Atlantic right whales (*Eubalaena*) using DNA fingerprinting. *Can. J. Zool*. 75: 1073-1080.

Schmidly, D. J., C. O. Martin and G. F. Collins. 1972. First occurrence of a black right whale (*Balaena glacialis*) along the Texas coast. *Southw. Nat.* 17(2): 214-215.

Wade, P. R., and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop, April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NOAA Fisheries-OPR-12. U.S. Dept. of Commerce, Washington, D.C. 93 pp.

MINKE WHALE (*Balaenoptera acutorostrata*): Canadian East Coast Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Minke whales have a cosmopolitan distribution in polar, temperate and tropical waters. In the North Atlantic there are four recognized populations — Canadian East Coast, west Greenland, central North Atlantic, and northeastern North Atlantic (Donovan 1991). These four population divisions were defined by examining segregation by sex and length, catch distributions, sightings, marking data and pre-existing ICES boundaries; however, there were very few data from the Canadian East Coast population.

Minke whales off the eastern coast of the United States are considered to be part of the Canadian East Coast stock, which inhabits the area from the eastern half of the Davis Strait (45°W) to the Gulf of Mexico. The relationship between this and the other three stocks is uncertain. It is also uncertain if there are separate stocks within the Canadian East Coast stock.

The minke whale is common and widely distributed within the U.S. Atlantic Exclusive Economic Zone (EEZ) (CETAP 1982). There appears to be a strong seasonal component to minke whale distribution. Spring and summer are times of relatively widespread and common occurrence, and during this time they are most abundant in New England waters. During fall in New England waters, there are fewer minke whales, while during winter, the species appears to be largely absent. Like most other baleen whales, the minke whale generally occupies the continental shelf proper, rather than the continental shelf edge region. Records summarized by Mitchell (1991) hint at a possible winter distribution in the West Indies and in mid-ocean south and east of Bermuda. As with several other cetacean species, the possibility of a deep-ocean component to distribution exists but remains unconfirmed.

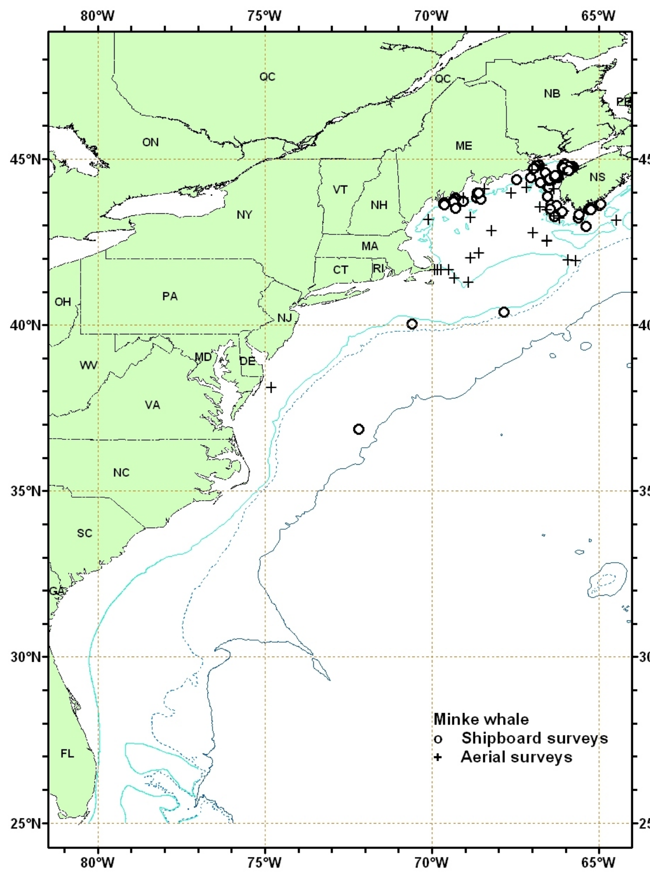

Figure 1. *Distribution of minke whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, and 2004. Isobaths are the 100m, 1000m and 4000m depth contours.*

POPULATION SIZE

The total number of minke whales in the Canadian East Coast population is unknown. However, seven estimates are available for portions of the habitat — a 1978-1982 estimate, a shipboard survey estimate from the summers of 1991 and 1992, a shipboard estimate from June-July 1993, an estimate made from a combination of shipboard and aerial surveys conducted during July to September 1995, an aerial survey estimate of the entire Gulf of St. Lawrence conducted in August to September 1995, an aerial survey estimate from the northern Gulf of St. Lawrence conducted during July and August 1996, and an aerial/shipboard survey conducted from Georges Bank to the mouth of the Gulf of St. Lawrence during July and August 1999 (Table 1; Figure 1).

An abundance of 320 minke whales (CV=0.23) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982).

An abundance of 2,650 (CV=0.31) minke whales was estimated from two shipboard line-transect surveys conducted during July to September 1991 and 1992 in the northern Gulf of Maine-lower Bay of Fundy region. This abundance estimate is a weighted-average of the 1991 and 1992 estimates, where each annual estimate was weighted by the inverse of its variance, using methods as described in Palka (1995).

An abundance of 330 minke whales (CV=0.66) was estimated from a June and July 1993 shipboard line-transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Anon. 1993).

An abundance of 2,790 (CV=0.32) minke whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Palka Unpub. Ms.). Total track line length was 32,600 km. The ships covered waters between the 50 and 1000 fathom isobaths, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour. Data collection and analysis methods were described in Palka (1996).

Kingsley and Reeves (1998) estimated there were 1,020 (CV=0.27) minke whales in the entire Gulf of St. Lawrence in 1995 and 620 (CV=0.52) in the northern Gulf of St. Lawrence in 1996 (Table 1). During the 1995 survey, 8,427km of track lines were flown in an area of 221,949 km^2 during August and September. During the 1996 survey, 3,993km of track lines were flown in an area of 94,665 km^2 during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line-transect methods that model the left truncated sighting curve. These estimates were uncorrected for visibility biases such as *g(0)*, the probability of detecting a group on the track line.

An abundance of 2,998 (CV=0.19) minke whales was estimated from a July to August 1999 sighting survey conducted by a ship and airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence (Table 1; D. Palka, Unpub. Ms.). Total track line length was 8,212km. Using methods similar to that used in the above 1995 Virginia to Gulf of St. Lawrence survey, shipboard data were analyzed using the modified direct duplicate method that accounts for school size bias and *g(0)*. Aerial data were not corrected for *g(0)* (Palka 2000).

The best available current abundance estimate for minke whales, 3,618 (CV=0.186), is the sum of the 1999 Georges Bank to Gulf of St. Lawrence estimate (2,998 (CV=0.19)) and the 1996 northern Gulf of St. Lawrence estimate (620 (CV=0.52)), because these surveys are recent and provided the most complete coverage of the known habitat.

Table 1. Summary of recent abundance estimates for Canadian East Coast minke whales. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Row Number	Month/Year	Area	N_{best}	CV
1	Jul-Aug 1996	northern Gulf of St. Lawrence	620	0.52
2	July-Aug 1999	Georges Bank to mouth of Gulf of St. Lawrence	2,998	0.19
3	Jul-Aug 1996 + July-Aug 1999	Georges Bank to Gulf of St. Lawrence (SUM OF ROWS 1 AND 2)	3,618	0.18

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for minke whales is 3,618. The minimum population estimate for the Canadian East Coast minke whale is 3,111.

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: females mature when 6-8 years old; pregnancy rates are approximately

0.86 to 0.93; thus, the calving interval is between 1 and 2 years; calves are probably born during October to March, after 10 to 11 months gestation; nursing lasts for less than 6 months; maximum ages are not known, but for Southern Hemisphere minke whales the maximum age appears to be about 50 years (Katona et al. 1993; IWC 1991).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow et al. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 3,111. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the Canadian east coast minke whale is 31.

ANNUAL HUMAN-CAUSED MORTALITY AND INJURY

Recent minke whale takes have been observed in or attributed to the Gulf of Maine and mid-Atlantic lobster trap/pot, mid-Atlantic coastal gillnet, and unknown fisheries; although all takes have not resulted in mortalities (Tables 2-5).

Data to estimate the mortality and serious injury of minke whales come from the U.S. Sea Sampling Program and from records of strandings and entanglements in U.S. waters. Estimates using the Sea Sampling Program data are discussed by fishery under the Fishery Information section below. Strandings and entanglement records are discussed under the lobster trap fishery, mid-Atlantic coastal gillnet fishery, and "Unknown Fisheries" within the Fishery Information section and under the Other Mortality section (Tables 2 to 5). Ship strike mortalities and serious injuries are discussed under the Other Mortality section (Tables 3 and 4). For the purposes of this report, only those strandings and entanglement records considered confirmed human-caused mortalities or serious injuries are shown in Tables 3 and 4.

During 1999 to 2003, the U.S. total annual estimated average human-caused mortality was 3.6 minke whales per year (CV=unknown). This is derived from three components: 0 minke whales per year (CV=0.0) from U.S. fisheries using observer data, 3.6 minke whales per year from U.S. fisheries using strandings and entanglement data, and 0.0 minke whales per year from ship strikes. During 1997 to 2001, there were no confirmed mortalities or serious injuries in Canadian waters as reported by the various, small scale stranding and observer data collection programs in Atlantic Canada. No additional information available on Canadian mortalities from 2002 to present.

Fishery Information

Detailed fishery information is reported in Appendix III.

Earlier Interactions

Little information is available about fishery interactions that took place before the 1990's. Read (1994) reported that a minke whale was found dead in a Rhode Island fish trap in 1976. A minke whale was caught and released alive in the Japanese tuna longline fishery in 3,000 m of water, south of Lydonia Canyon on Georges Bank, in September 1986 (Waring et al. 1990).

Two minke whales were observed taken in the Northeast sink gillnet fishery between 1989 and the present. The take in July 1991, south of Penobscot Bay, Maine resulted in a mortality, and the take in October 1992, off the coast of New Hampshire near Jeffreys Ledge was released alive.

A minke whale was trapped and released alive from a herring weir off northern Maine in 1990.

Four minke whale mortalities were observed in the Atlantic pelagic drift gillnet fishery during 1995 so the estimated annual fishery-related mortality and serious injury was 4.5 (CV=0).

In an Atlantic tuna purse seine off Stellwagen Bank, one minke whale was reported caught and released uninjured in 1991(D. Beach, NMFS NE Regional Office, pers. comm.) and in 1996. The minke caught during 1991 escaped after a crew member cut the rope that was wrapped around the tail. The minke whale caught during 1996 escaped by diving beneath the net.

One minke whale, reported in the strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, was taken in a 6-inch gill net on 06 July 1998 off Long Island, New York. This take was assigned to the mid-Atlantic coastal gillnet fishery. No minke whales have been taken from this fishery during observed trips in 1993 to 2003.

U.S.

Gulf of Maine and mid-Atlantic Lobster Trap/Pot Fishery

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, reported 7 minke whale mortalities and serious injuries that were attributed to the lobster fishery during 1990 to 1994; 1 in 1990 (may be serious injury), 2 in 1991 (1 mortality and 1 serious injury), 2 in 1992 (both mortalities), 1 in 1993 (serious injury) and 1 in 1994 (mortality) (1997 List of Fisheries 62FR33, January 2, 1997). The 1 confirmed minke whale mortality during 1995 was attributed to the lobster fishery. No confirmed mortalities or serious injuries of minke whales occurred in 1996. From the 4 confirmed 1997 records, 1 minke whale mortality was attributed to the lobster trap fishery. One minke whale was disentangled and released alive from lobsterman's gear on 21 August 2002 (Table 2). No minke whale mortalities were attributed to this fishery for other years. Annual mortalities due to this fishery, as determined from strandings and entanglement records that have been audited, were 1 in 1991, 2 in 1992, 1 in 1994, 1 in 1995, 0 in 1996, 1 in 1997 and 0 in 1998 to 2003. Estimated average annual mortality related to this fishery during 1999 to 2003 was 0 minke whales per year (Table 3).

Unknown Fisheries

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, included 36 records of minke whales within U.S. waters for 1975-1992. The gear included unspecified fishing net, unspecified cable or line, fish trap, weirs, seines, gillnets, and lobster gear. A review of these records is not complete. One confirmed entanglement was an immature female minke whale, entangled with line around the tail stock, that came ashore on the Jacksonville, Florida jetty on 31 January 1990 (R. Bonde, USFWS, Gainesville, FL, pers. comm.).

The audited NE Regional Office/NMFS entanglement/stranding database for 1995 to 2003 contains 49 records of minke whales, of which the confirmed mortalities and serious injuries are reported in Table 4. Mortalities (and serious injuries) that were likely a result of a fishery interaction with an unknown fishery include 3 (0) in 1997, 3 (0) in 1999, 1 (1) in 2000, 3 (2) in 2001, 2 (0) in 2002, 4 (0) in 2003 and 0 in other years. The examination of the minke entanglement records from 1997 indicate that 4 out of 4 confirmed records of mortality are likely a result of fishery interactions, one attributed to the lobster pot fishery (see above), and three not attributed to any particular fishery because the reports do not contain the necessary details. Of the 5 mortalities in 1999, 2 were attributed to an unknown trawl fishery and 3 to some other fishery. One of the interactions with an unknown fishery in 2000 was a mortality and 1 was a serious injury. In 2001, of the 5 confirmed fishery interactions, 3 interactions were mortalities in an unknown fishery and 2 were serious injuries in an unknown fishery. In 2002 and 2003, the 2 and 4 confirmed fishery interactions, respectively, were mortalities in an unknown fishery (Tables 3 and 4).

In general, an entangled or stranded cetacean could be an animal that is part of an expanded bycatch estimate from an observed fishery and thus it is not possible to know if an entangled or stranded animal is an additional mortality. During 1997 to 2003, there were no minke whales observed taken in any fishery that participated in the Sea Sampling Program, therefore, the strandings where mortality was due to a fishery interaction can be added into the human-caused mortality estimate. During 1999 to 2003, as determined from strandings and entanglement records, the estimated average annual mortality is 0.4 minke whales per year in unknown trawl fisheries, and 3.2 minke whales per year in unknown fisheries, resulting in an average of 3.6 average annual mortalities due to unknown fisheries (Table 3).

CANADA

In Canadian waters, information about minke whale interactions with fishing gear is not well quantified or recorded, though some records are available. Read (1994) reported interactions between minke whales and gillnets in Newfoundland and Labrador, cod traps in Newfoundland, and herring weirs in the Bay of Fundy. Hooker et al. (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on between 25% and 40% of large Canadian fishing vessels (greater than 100 feet long), and on approximately 5% of smaller Canadian fishing vessels. During 1991 through 1996, no minke whales were observed taken.

Herring Weirs

During 1980 to 1990, 15 of 17 minke whales were released alive from herring weirs in the Bay of Fundy. Due to the formation of a cooperative program between Canadian fishermen and biologists it is expected that now most minke whales will be able to be released alive. During January 1991 to September 2002, 26 minke whales were trapped in herring weirs in the Bay of Fundy. Of these 26, 1 died (H. Koopman, pers. comm.) and several (number unknown) were released alive and unharmed (A. Westgate, pers. comm.).

Other Fisheries

Six minke whales were reported entangled during 1989 in the now non-operational groundfish gillnet fishery in Newfoundland and Labrador (Read 1994). One of these animals escaped and was still towing gear, the remaining 5 animals died.

Salmon gillnets in Canada, now no longer being used, had taken a few minke whales. In Newfoundland in 1979, one minke whale died in a salmon net. In Newfoundland and Labrador, between 1979 and 1990, it was estimated that 15% of the Canadian minke whale takes were in salmon gillnets. A total of 124 minke whale interactions were documented in cod traps, groundfish gillnets, salmon gillnets, other gillnets and other traps. This fishery ended in 1993 as a result of an agreement between the fishermen and North Atlantic Salmon Fund (Read 1994).

Five minke whales were entrapped and died in Newfoundland cod traps during 1989. The cod trap fishery in Newfoundland closed in 1993 due to the depleted groundfish resources (Read 1994).

Table 2. Summary of minke whales (*Balaenoptera acutorostrata*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured). (N/A = Not Available)

Fishery	Years	Ratio	Injured	Uninjured
Lobster trap pot	none	NA[1]	1[1]	0

[1] Minke whale disentangled and released alive from lobster gear by owner of gear on 21 August 2002 near Mount Desert Island, ME.

Table 3. From strandings and entanglement data, summary of confirmed incidental mortalities and serious injuries of minke whales (*Balaenoptera acutorostrata*) by commercial fishery: includes years sampled (Years), number of vessels active within the fishery (Vessels), type of data used (Data Type), mortalities and serious injuries assigned to this fishery (Assigned Mortality), and mean annual mortality and serious injuries. See Table 4 for details. (NA=Not Available)

Fishery	Years	Vessels	Data Type [1]	Assigned Mortality	Mean Annual Mortality
GOM and mid-Atlantic Lobster Trap/Pot	99-03	1997=6880 2000=7539 licenses	Entanglement & Strandings	0, 0, 0, 0, 0	0.0
Unknown Trawl	99-03	NA	Entanglement & Strandings	2, 0, 0, 0, 0	0.4
Unknown Fisheries	99-03	NA	Entanglement & Strandings	3, 2, 5, 2, 4	3.2
TOTAL					3.6 (unk)

[1] Data from records in the entanglement and strandings data base maintained by the New England Aquarium and the Northeast Regional Office/NMFS (Entanglement and Strandings).

Table 4. Summarized records of mortality and serious injury likely to result in mortality. Canadian East Coast stock of minke whales, January 1999 - December 2003. This listing includes only confirmed records related to U.S. commercial fisheries and/or ship strikes in U.S. waters. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFS/NER and NMFS/SER.

Date[1]	Report Type[2]	Sex, age, ID	Location[1]	Assigned Cause[3]: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unk/ uncertain	
5/9/99	mortality	female 5.6m	Cape Lookout Bight (34° 61'N 76° 54'W)		P		Unknown fishery. Fresh open wounds around fluke and line marks from pectoral fins through mouth.
6/16/99	mortality	female 6.9m	Orleans, MA (41° 48'N 65° 56'W)		P		Unknown fishery. Extensive rope markings with hemorrhaging.
7/3/99	mortality	unk sex and size	Sakonnet River, RI (41°48'N 71°12'W)		P		Trawl fishery. 4.5 inch stretched mesh driven into rostrum.
8/2/99	mortality	unk sex and size	Point Judith Light, RI (41°23'N 71°28'W)		P		Trawl fishery. 6 inch stretched mesh tightly wrapped around rostrum.
10/2/99	mortality	female 7.2m	Provincetown, MA (42°03'N 70°21'W)		P		Unknown fishery. Rope marks on left gape of mouth, left pectoral fin, caudal peduncle, and dorsal and ventral surfaces of fluke blades.
8/11/00	serious injury	unk sex and size	Port Clyde, ME (43°55'N 69°11'W)		P		Unknown fishery. Dark line with several bullet buoys. Unusual minke behavior - whale probably anchored.
8/26/00	mortality	unk sex and size	Rockland ME (44°05'N 69°01'W)		P		Unknown fishery. Very fresh carcass with fresh entanglement wounds on tail stock.
6/13/01	serious injury	unk sex, 7.6m (est)	Cape Cod (42°06'N 70°08'W0		P		Unknown fishery. Animal free-swimming with tangle of line behind blowhole, trailing line on left side.

Date[1]	Report Type[2]	Sex, age, ID	Location[1]	Assigned Cause[3]: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unk/ uncertain	
7/27/01	mortality	female, 3.9m (est)	Whale Rock, RI (41°26'N 71°25'W)		P		Unknown fishery. Line wrapped behind head and dorsal fin.
8/17/01	mortality	male, 3.9m	Middletown, RI (41°28'N 71°15'W)		P		Unknown fishery. Severe rope entanglement around mouth and rostrum caused malnutrition and infection.
10/20/01	serious injury	unk sex, 6.1m (est)	Stellwagen Bank (42°11'N 70°10'W)		P		Unknown fishery. Line with high flyer attached.
12/13/01	mortality	unk sex, 7m (est)	Massachusetts Bay (42° 21'N 70°43'W)		P		Unknown fishery. Pictures show evidence of fairly fresh entanglement marks on tail stock and across tail flukes.
7/17/02	mortality	female, 4.6m (est)	Bar Harbor, ME (44° 18.22'N 68° 07.43'W)		P		Unknown fishery. Carcass had a rope scar on the peduncle with associated hemorrhaging. Additional bruising around the epiglottis and larynx
10/15/02	mortality	female, 5.14m	Gloucester, MA (42° 36'N 70° 39W)		P		Unknown fishery. Whale was entangled through the mouth and around the pectoral flippers. Gear was still on the whale.
5/13/03	mortality	female, 7.4m	Gloucester, MA (42° 35.8'N 70° 38.3'W)		P		Unknown fishery. Line marks on animal, no line present.
5/24/03	mortality	male, 7.6m	Glouster, MA (42° 40.8'N 70° 39.6'W)		P		Unknown fishery. Line marks on head and dorsal fin, no line present. Cut across back anterior to dorsal fin.

Date[1]	Report Type[2]	Sex, age, ID	Location[1]	Assigned Cause[3]: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unk/ uncertain	
5/31/03	mortality	female, 3.6m (est)	Martha's Vineyard, MA (41° 21.0'N 70° 47.5'W)		P		Unknown fishery. Whale stranded live wrapped in about 15 feet of 2-3 inch mesh netting.
8/9/03	mortality	unk sex, 3.5m (est)	Harwich, MA (41° 37.3'N 70° 03.0'W)		P		Unknown fishery. Net marks on whale. Gear not found.

1. The date sighted and location provided in the table are not necessarily when or where the serious injury or mortality occurred; rather, this information indicates when and where the whale was first reported beached, entangled, or injured.
2. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (62 FR 33, Jan. 2, 1997) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
3. Assigned cause based on best judgement of available data. Additional information may result in revisions.

Other Mortality

Minke whales have been and are still being hunted in the North Atlantic. From the Canadian East Coast population, documented whaling occurred from 1948 to 1972 with a total kill of 1,103 animals (IWC 1992). Animals from other North Atlantic populations are presently still being harvested at low levels.

U.S.

Minke whales inhabit coastal waters during much of the year and are subject to collision with vessels. According to the NMFS/NER marine mammal entanglement and stranding database, on 7 July 1974, a necropsy of a minke whale suggested a vessel collision occurred; on 15 March 1992, a juvenile female minke whale with propeller scars was found floating east of the St. Johns Channel entrance (R. Bonde, USFWS, Gainesville, FL, pers. comm.); and on 15 July 1996 the captain of a vessel reported they hit a minke whale offshore of Massachusetts. After reviewing this record, it was concluded the animal struck was not a serious injury or mortality. On 12 December 1998, a minke whale was struck and presumed killed by a whale watching vessel in Cape Cod Bay off Massachusetts.

During 1999 to 2003, no minke whale was confirmed struck by a ship, thus, there is an annual average of 0.0 minke whales per year struck by ships (Table 4).

In October 2003 an Unusual Mortality Event was declared involving minke whales and harbor seals along the coast of Maine. Two of the seven criteria established to designate such an event were met by these species. Specifically, there was a marked increase in mortalities when compared with historical records and the mortalities were occurring in a localized area of the Maine coast. From September 11-30, 2003, nine minke whales were reported along the mid-coast to southern Maine. Results from analyses for biotoxins failed to show the presence of either of the biotoxins, saxitoxin or domoic acid (by ELISA and Receptor Binding Assay). Most whale carcasses reported that were examined appeared to be in good body condition immediately prior to death. Since October 2003, the number of minke whale stranding reports has returned to normal.

CANADA

Whales and dolphins stranded between 1991 and 1996 on the coast of Nova Scotia were documented by the Nova Scotia Stranding Network (Hooker et al. 1997). Strandings on the beaches of Sable Island were documented by researchers with Dept. of Fisheries and Oceans, Canada (Lucas and Hooker 2000). Sable Island is approximately 170km southeast of mainland Nova Scotia. Lucas and Hooker (2000) report 4 minke whales stranded on Sable Island between 1970 and 1998, 1 in spring 1982, 1 in January 1992, and a mother/calf in December 1998. On the mainland of Nova Scotia, a total of 7 reported minke whales stranded during 1991 to 1996. The 1996 stranded minke whale was released alive off Cape Breton on the Atlantic Ocean side, the rest were found dead. All the minke whales stranded between July and October. One was from the Atlantic Ocean side of Cape Breton, 1 from Minas Basin, 1 was at an unknown location, and the rest stranded in the vicinity of Halifax, Nova Scotia. It is unknown how many of the strandings can be attributed to fishery interactions.

Whales and dolphins stranded between 1997 and 2004 on the coast of Nova Scotia as recorded by the Marine Animal Response Society (MARS) and the Nova Scotia Stranding Network are as follows (Table 5): 4 minke whales stranded in 1997 (1 in June and 3 in July), 0 documented strandings in 1998 to 2000, 1 in September 2001, 4 in 2002 (1 in July,1 in August and 2 in November), 2 in 2003 (1 in August and 1 in October) and 0 in 2004.

Table 5. Documented number of stranded minke whales along the coast of Nova Scotia during 1999 to 2003 by year, according to records maintained by the Canadian Marine Animal Response Society.

Area	Year					
	1999	2000	2001	2002	2003	Total
Nova Scotia	0	0	1	4	3	8

STATUS OF STOCK

The status of minke whales, relative to OSP, in the U.S. Atlantic EEZ is unknown. The minke whale is not listed as endangered under the Endangered Species Act (ESA). The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because estimated fishery-related mortality and serious injury do not exceed PBR and the minke whale is not listed as a threatened or endangered species under the ESA.

REFERENCES

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine Mammal Survey. 5 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Donovan, G. P. 1991. A review of IWC stock boundaries. *Rep. int Whal. Commn* Special Issue 13: 39-68.

Hooker, S. K., R. W. Baird and M. A. Showell. 1997. Cetacean strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Meeting document SC/49/O5 submitted to the 1997 International Whaling Commission meeting in Bournemouth, UK.

IWC [International Whaling Commission]. 1991. Appendix 11. Biological parameters of North Atlantic minke whales in Annex F Report of the sub-committee on North Atlantic Minke whales. *Rep. int Whal. Commn* 41: 160.

IWC [International Whaling Commission]. 1992. Annex K. Report of the working group on North Atlantic Minke trials. *Rep. int Whal. Commn* 42: 246-251.

Katona, S. K., V. Rough and D. T. Richardson. 1993. *A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland*. Smithsonian Institution Press. Washington D.C. 316 pp.

Kingsley, M.C.S. and R.R. Reeves. 1998. Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. *Can. J. Zool.* 76:1529-1550.

Lucas, Z. N. and S. K. Hooker. 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. *Canadian Field-Naturalist* 114(1): 46-61.

Mitchell, E. D. 1991. Winter records of the minke whale (*Balaenoptera acutorostrata* Lacepede 1804) in the southern North Atlantic. *Rep. int Whal. Commn* 41: 455-457.

Palka, D. 2000. Abundance of the Gulf of Maine/Bay of Fundy harbor porpoise based on shipboard and aerial surveys during 1999. NOAA/NMFS/NEFSC Ref. Doc. 00-07; 29 pp. [Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543.]

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. pp. 27-50. *In*: A. Bjørge and G.P.

Donovan (eds.) Biology of the Phocoenids. *Rep. int Whal. Commn* Special Issue 16.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA-NMFS-NEFSC Ref. Doc. 96-04; 37p. [Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543.]

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int Whal. Commn* Special Issue 15: 133-147.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S.* 88(2): 347-360.

November 2004

SPERM WHALE (*Physeter macrocephalus*): North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of the sperm whale in the U.S. Exclusive Economic Zone (EEZ) occurs on the continental shelf edge, over the continental slope, and into mid-ocean regions (Figure 1). Waring *et al.* (1993; 2001) suggest that this offshore distribution is more commonly associated with the Gulf Stream edge and other features. However, the sperm whales that occur in the eastern U.S. Atlantic EEZ likely represent only a fraction of the total stock. The nature of linkages of the U.S. habitat with those to the south, north, and offshore is unknown. Historical whaling records compiled by Schmidly (1981) suggested an offshore distribution off the southeast U.S., over the Blake Plateau, and into deep ocean. In the southeast Caribbean, both large and small adults, as well as calves and juveniles of different sizes are reported (Watkins *et al.* 1985). Whether the northwestern Atlantic population is discrete from northeastern Atlantic is currently unresolved. The International Whaling Commission recognizes one stock for the North Atlantic. Based on reviews of many types of stock studies, (i.e., tagging, genetics, catch data, mark-recapture, biochemical markers, etc.) Reeves and Whitehead (1997) and Dufault *et al.* (1999) suggest that sperm whale populations have no clear geographic structure. Recent ocean-wide genetic studies (Lyrholm and Gyllensten 1998; Lyrholm *et al.* 1999) indicate low genetic diversity, but strong differentiation between potential social (matrilineally related) groups. Further, the ocean-wide findings, combined with observations from other studies, indicate stable social groups, site fidelity, and latitudinal range limitations in groups of females and juveniles (Whitehead 2003). In contrast, males migrate to polar regions to feed and return to more tropical waters to breed. There exists one tag return of a male tagged off Browns Bank (Nova Scotia) in 1966 and returned from Spain in 1973 (Mitchell 1975). Another male taken off northern Denmark in August 1981 had been wounded the previous summer by whalers off the Azores (Reeves and Whitehead 1997). In the U.S. Atlantic EEZ waters, there appears to be a distinct seasonal cycle (CETAP 1982; Scott and Sadove 1997). In winter, sperm whales are concentrated east and northeast of Cape Hatteras. In spring, the center of distribution shifts northward to east of Delaware and Virginia, and is widespread throughout the central portion of the mid-Atlantic bight and the southern portion of Georges Bank. In summer, the distribution is similar but now also includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100m isobath) south of New England. In the fall, sperm whale occurrence south of New-England on the continental shelf is at its highest level, and there remains a continental shelf edge occurrence in the mid-Atlantic bight. Similar inshore (<200m) observations have been made on the southwestern (Kenney, pers. comm) and eastern Scotian Shelf, particularly in the region of “the Gully” (Whitehead *et al.* 1991).

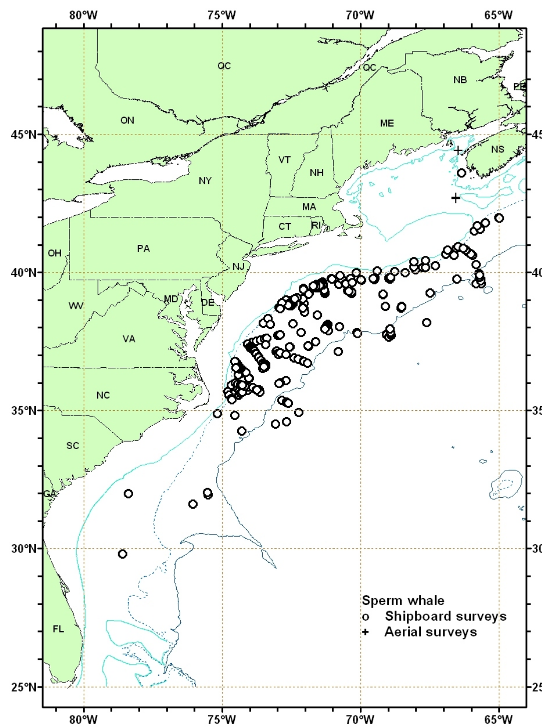

Figure 1. Distribution of sperm whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1998, 1999 and 2004. Isobaths are at 100 m, 1,000 m, and 4,000 m.

Geographic distribution of sperm whales may be linked to their social structure and their low reproductive rate and both of these factors have management implications. Several basic groupings or social units are generally recognized — nursery schools, harem or mixed schools, juvenile or immature schools, bachelor schools, bull schools or pairs, and solitary bulls (Best 1979; Whitehead *et al.* 1991). These groupings have a distinct geographical distribution, with females and juveniles generally based in tropical and subtropical waters, and males more wide-ranging and occurring in higher latitudes. Male sperm whales are present off and sometimes on the continental shelf along the entire east coast of Canada south of Hudson Strait, whereas, females rarely migrate north of the southern limit of the Canadian EEZ (Reeves and Whitehead 1997). Off the northeast U.S., CETAP and NMFS/NEFSC sightings in shelf-edge and off-shelf waters included many social groups with calves/juveniles (CETAP 1981; Waring *et al.* 1992, 1993). The basic social unit of the sperm whale appears to be the mixed school of adult females plus their calves and some juveniles of both sexes, normally numbering 20-40 animals in all. There is evidence that some social bonds persist for many years.

POPULATION SIZE

Total numbers of sperm whales off the U.S. or Canadian Atlantic coast are unknown, although several estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 219 (CV=0.36) sperm whales was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 338 (CV=0.31) sperm whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Anon. 1990; Waring *et al.* 1992). An abundance of 736 (CV=0.33) sperm whales was estimated from a June and July 1991 shipboard line-‑transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). An abundance of 705 (CV=0.66) and 337 (CV=0.50) sperm whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 116 (CV=0.40) sperm whales was estimated from a June and July 1993 shipboard line-transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for *g(0)* or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 623 (CV=0.52) sperm whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Anon. 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for *g(0)* or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 2,698 (CV=0.67) sperm whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Palka *et al.* Unpubl. Ms.). Total track line length was 32,600km. The ships covered waters between the 50 and 1000 fathom isobaths , the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom isobath , the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom isobath . Data collection and analysis methods used were described in Palka (1996).

An abundance of 2,848 (CV=0.49) sperm whales was estimated from a line- transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900km of track line in waters north of Maryland (38° N) (Figure 1; Table 1; Palka *et al.* Unpubl. Ms.). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)*.

An abundance of 1,181 (CV=0.51) sperm whales was estimated from a shipboard line‑-transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 4,163km of track line in waters south of Maryland (38°N) (Figure 1; Mullin and Fulling 2003). This estimate is a recalculation of the same data reported in previous SARs. For more details see Mullin and Fulling (2003). Abundance estimates were made using the program DISTANCE (Buckland *et al.et al.* 1993) where school size bias and ship attraction were accounted for.

The best 1998 abundance estimate for sperm whales is the sum of the estimates from the two U.S. Atlantic surveys, 4,029 (CV=0.38), where the estimate from the northern U.S. Atlantic is 2,848 (CV=0.49) and from the southern U.S. Atlantic is 1,181 (CV=0.51). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

An abundance of 1,571 (CV=0.479) for sperm whales was estimated from a line -transect sighting survey conducted during June 12 to August 4, 2004 by a ship and plane that surveyed 10,761 km of track line in waters north of Maryland (about 38° N) to the Bay of Fundy (about 45° N) (Figure 1; Palka Unpub. Ms.). Shipboard data were collected using the two independent team line transect method and analyzed using the modified direct duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and g(0), the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line transect method (Hiby 1999) and analyzed accounting for g(0) and biases due to school size and other potential covariates (Figure 1; Palka unpub.).

A survey of the U.S. Atlantic outer continental shelf and continental slope (water depths ≥ 50m) between Florida and Maryland (27.5 and 38º N latitude) was conducted during June-August, 2004. The survey employed two independent visual teams searching with 50x bigeye binocluars. Survey effort was stratified to include increased effort along the continental shelf break and Gulf stream front in the mid-Atlantic. The survey included 5,659 km of trackline, and there were a total of 473 cetacean sightings. Sightings were most frequent in waters north of Cape Hatteras, North Carolina along the shelf break. Data were analyzed to correct for visibility bias (*g(0)*) and group-size bias employing line transect distance analysis and the direct duplicate estimator (Palka, 1995; Buckland *et al.*, 2001). The resulting abundance estimate for sperm whales between Florida and Maryland was 2,197 (CV =0.465).

The best 2004 abundance estimate for sperm whales is the sum of the estimates from the two 2004 U.S. Atlantic surveys, 3,768 (CV =0.337), where the estimate from the northern U.S. Atlantic is 1,571 (CV =0.479) , and from the southern U.S. Atlantic is 2,197 (CV =0.465). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Because all the sperm whale estimates presented here were not corrected for dive-time, they are likely downwardly biased and an underestimate of actual abundance. The average dive-time of sperm whales is approximately 30 - 60 min (Whitehead *et al.* 1991; Watkins *et al.* 1993; Peter Madsen, Woods Hole Oceanographic Institution, pers. comm.), therefore, the proportion of time that they are at the surface and available to visual observers is assumed to be low.

Although the stratification schemes used in the 1990-2004 surveys did not always sample the same areas or encompass the entire sperm whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective 1990- 2004 data suggest that, seasonally, at least several thousand sperm whales are occupying these waters. Sperm whale abundance may increase offshore, particularly in association with Gulf Stream and warm-core ring features; however, at present there is no reliable estimate of total sperm whale abundance in the western North Atlantic.

Table 1. Summary of abundance estimates for the western North Atlantic sperm whale. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	2,848	0.49
Jul-Aug 1998	Florida to Maryland	1,181	0.51
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	4,029	0.38
Jun-Aug 2004	Maryland to the Bay of Fundy	1,571	0.479
Jun-Aug 2004	Florida to Maryland	2,197	0.465
Jun-Aug 2004	Bay of Fundy to Florida (COMBINED)	3,768	0.337

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for sperm whales is 3,768 (CV =0.337). The minimum population estimate for the western North Atlantic sperm whale is 2,860.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. While more is probably known about sperm whale life history in other areas, some life history and vital rates information is available for the northwest Atlantic. These include: calving interval is 4-6 years; lactation period is 24 months; gestation period is 14.5-16.5 months; births occur mainly in July to November; length at birth is 4.0m; length at sexual maturity 11.0-12.5m for males and 8.3-9.2m for females; mean age at sexual maturity is 19 years for males and 9 years for females; and mean age at physical maturity is 45 years for males and 30 years for females (Best 1974; Best *et al.* 1984; Lockyer 1981; Rice 1989).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 2,860. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the sperm whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic sperm whale is 5.7.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

During 1999-2003, human caused mortality was 0.4 sperm whales per year (CV=unknown). This is derived from three components: 0 sperm whales per year (CV=unknown) from U.S. fisheries using observer data; 0.2 sperm whales based on the 2000 stranding of a sperm whale off Florida which had fishing gear in its blow hole; and 0.2 sperm whales per year from ship strikes.

Fishery Information

Detailed fishery information is reported in Appendix III. Bycatch has been observed by NMFS Sea Samplers in the now prohibited pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in other US Atlantic fisheries by NMFS Sea Samplers.

Earlier Interactions

Several sperm whale entanglements have been documented. In July 1990, a sperm whale was entangled and subsequently released (injured) from the now prohibited pelagic drift gillnet near the continental shelf edge on southern Georges Bank. This resulted in an estimated annual fishery-related mortality and serious injury of 4.4 (CV=1.77) for 1990. In August 1993, a dead sperm whale, with longline gear wound tightly around the jaw, was found floating about 20 miles off Mt Desert Rock. In October 1994, a sperm whale was successfully disentangled from a fine-‑mesh gillnet in Birch Harbor, Maine. During June 1995, one sperm whale was entangled with “gear in/around several body parts” then released injured from a pelagic drift gillnet haul located on the shelf edge between Oceanographer and Hydrographer Canyons on Georges Bank. In May 1997, a sperm whale entangled in net with three buoys trailing was sighted 130 nmi northwest of Bermuda. No information on the status of the animal was provided.

Other Mortality

Four hundred twenty-four sperm whales were harvested in the Newfoundland-Labrador area between 1904-1972 and 109 male and no female sperm whales were taken near Nova Scotia in 1964-1972 (Mitchell and Kozicki 1984) in a Canadian whaling fishery. There was also a well-documented sperm whale fishery based on the west coast of Iceland. Other sperm whale catches occurred near West Greenland, the Azores, Madeira, Spain, Spanish Morocco, Norway (coastal and pelagic), Faroes, and British coastal. At present, because of their general offshore distribution, sperm whales are less likely to be impacted by humans and those impacts that do occur are less likely to be recorded. There has been no complete analysis and reporting of existing data on this topic for the western North Atlantic.

During 1994-2000, eighteen sperm whale strandings have been documented along the U.S. Atlantic coast between Maine and Miami, Florida (NMFS unpublished data). One 1998 and one 2000 stranding off Florida showed signs of human interactions. The 1998 animal’s head was severed, but it is unknown if it occurred pre- or post-mortem. The 2000 animal had fishing gear in the blowhole. In October 1999, a live sperm whale calf stranded on eastern Long Island, and was subsequently euthanized. Also, a dead calf was found in the surf off Florida in 2000.

During 2001 to 2003, ten sperm whale strandings were documented along the U.S. Atlantic coast according the NER and SER strandings databases (Table 2). Except for the sperm whale struck by a naval vessel in the EEZ in 2001, there were no confirmed documented signs of human interactions on the other nine animals.

Table 2. Sperm whale (*Physeter macrocephalus*) reported stranding along the U.S. Atlantic coast.

State	**2001**	**2002**	**2003**	**Total**
Maine	--	--	--	--
Massachusetts	1	1	--	1
Virginia	--	--	--	--
North Carolina	--	--	2	2
South Carolina	--	1	--	1
Florida	--	2	2	4
EEZ	1[1]	--	--	1
Total	1	4	4	9

[1] U.S. Navy reported ship strike

In eastern Canada, 5 dead strandings were reported in Newfoundland/Labrador in 1987-1995; 13 dead strandings along Nova Scotia in 1988-1996; 7 dead strandings on Prince Edward Island in 1988-1991; 2 dead strandings in Quebec in 1992; and 13 animals in 8 stranding events on Sable Island, Nova Scotia in 1970-1998 (Reeves and Whitehead 1997; Hooker *et al.* 1997; Lucas and Hooker 2000). Sex was recorded for 11 of the 13 Sable island animals, and all were male, which is consistent with sperm whale distribution patterns (Lucas and Hooker 2000).

Recent mass strandings have been reported in the North Sea, including; winter 1994/1995 (21); winter 1995/1996 (16); and winter 1997/1998 (20). Reasons for the strandings are unknown, although multiple causes (e.g., unfavorable North Sea topography, ship strikes, global changes in water temperature and prey distribution, and pollution) have been suggested (Holsbeek *et al.* 1999).

Ship strikes are another source of human-induced mortality. In May 1994 a ship-struck sperm whale was observed south of Nova Scotia (Reeves and Whitehead 1997), and in May 2000 a merchant ship reported a strike in Block Canyon (NMFS, unpublished data). In spring, Block Canyon is a major pathway for sperm whales entering southern New England continental shelf waters in pursuit of migrating squid (CETAP 1982; Scott and Sadove 1997).

A potential human-caused source of mortality is from accumulation of stable pollutants (e.g., polychlorobiphenyls (PCBs), chlorinated pesticides (DDT, DDE, dieldrin, etc.), polycyclic aromatic hydrocarbons (PAHs), and heavy metals) in long-lived, high-trophic level animals. Analysis of tissue samples obtained from 21 sperm whales that mass -stranded in the North Sea in 1994/1995 indicated that mercury, PCB, DDE, and PAH levels were low and similar to levels reported for other marine mammals (Holsbeek *et al.* 1999). Cadmium levels were high and double reported levels in North Pacific sperm whales. Although the 1994/1995 strandings were not attributable to contaminant burdens, Holsbeek *et al.* (1999) suggest that the stable pollutants might affect the health or behavior of North Atlantic sperm whales.

Using stranding and entanglement data, during , one sperm whale was confirmed struck by a ship, thus, there is an annual average of 0.2 sperm whales per year struck by ships. In addition, during 1999-2003, one sperm whale was a confirmed fishery interaction, thus, there is an annual average of 0.2 sperm whales taken in U.S. fisheries.

STATUS OF STOCK

The status of this stock relative to OSP in U.S. Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine population trends. The current stock abundance estimate was based upon a small portion of the known stock range. Total fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR, and therefore can be considered to be insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the species is listed as endangered under the ESA.

REFERENCES

Anon. 1990. Cruise results, NOAA Ship CHAPMAN, Cruise No. 90-05. Marine Mammal Sighting Survey. 5 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA-NMFS-SEFSC and NEFSC. 4 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1993. Cruise results, NOAA Ship DELAWARE II, Cruise No. DEL 93-06, Marine Mammal Survey. 5 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1994. Cruise results, NOAA Ship RELENTLESS, Cruise No. RS 94-02, Marine Mammal Survey/Warm Core Ring Study. 8 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Best, P. B. 1974. Biology of the sperm whale. Pages 53-81. *In:* W. E. Schevill (ed), The whale problem: A status report. Harvard University Press, Cambridge, Massachusetts, 419 pp.

Best, P. B. 1979. Social organization in sperm whales, *Physeter macrocephalus*. Pages 227-289. *In:* H. E. Winn and B. L. Olla (eds), Behavior of marine animals, Vol. 3: Cetaceans. *Plenum Press*, New York.

Best, P. B., P. A. S. Canham and N. Macleod. 1984. Patterns of reproduction in sperm whales, *Physeter macrocephlus*. *Rep. int Whal. Commn.* (Special Issue 8):51-79.

Buckland, S. T., D.R. Andersen, K.P Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling estimating abundance of biological populations. *Oxford University Press*, New York, 432 pp.

Buckland, S. T., D. R. Andersen, K. P. Burnham and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 442 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Dufault, S., H. Whitehead, and M. Dillon. 1999. An examination of the current knowledge on the stock structure of sperm whales (*Physeter macrocephalus)* Worldwide. *J. Cetacean Res. Manage*. 1(1):1-10.

Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 *in*: Garner *et al.* (eds). Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.

Holsbeek, L., C. R. Joiris, V. Debacker, I. B. Ali, P. Roose, J-P. Nellissen, S. Gobert, J-M. Bouquegneau, and M. Bossicart. 1999. Heavy metals, organochlorines and polycyclic aromatic hydrocarbons in sperm whales stranded in the southern North Sea during the 1994/1995 winter. *Mar. Pollu. Bull.* 38: 4 304-313.

Hooker, S. K., R. W. Baird, and M. A. Showell. 1997. Cetacean Strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Paper SC/49/05 presented to the IWC Scientific Committee, September 1997. 11 pp.

Lockyer, C. 1981. Estimates of growth and energy budget for the sperm whale. Pages 491-504 *in:* Mammals in the seas, III. *FAO Fish. Ser. No. 5. FAO, Rome*, 504 pp.

Lucas, Z. N. and S. K. Hooker. 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. *Can. Field Nat.*:114 (45-61).

Lyrholm, T. and U. Gyllensten. 1998. Global matrilineal population structure in sperm whales as indicated by mitochondrial DNA sequences. *Proc. R. Soc. Lond*. B 265:1679-1684.

Lyrholm, T., O. Leimar, B. Johanneson, and U. Gyllensten. 1999. Sex-biased dispersal in sperm whales: contrasting mitochondrial and nuclear genetic structure of global populations. Proc. R. Soc. Lond. B 266: 347-354.

Mitchell, E. 1975. Progress report on whale research, Canada. *Rep. int Whal. Commn*. 25:270-272.

Mitchell, E. and V. M. Kozicki. 1984. Reproductive condition of male sperm whales, *Physeter macrocephalus*, taken off Nova Scotia. *Rep. int Whal. Commn.* (Special Issue 6):243-252.

Mullin, K. D. and G. L. Fulling. 2003. Abundance of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. *Fish. Bull., U.S.* 101:603-613.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. *Rep. int Whal. Commn.* (Special Issue 16):27-50.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Palka, D. and Hammond, P.S. 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci. 58: 777-787.

Reeves, R. R. and H. Whitehead. 1997. Status of sperm whale, *Physeter macrocephalus*, in Canada. *Can. Field Nat.* 111:293-307.

Rice, D. W. 1989. Sperm whale. *Physeter macrocephalus* Linnaeus, 1758. Pp. 177-233 *in:* Handbook of marine animals. Vol. 4. Ed. S. H. Ridgway and R Harrison. *Academic Press*, London.

Scott, T. M. and S. S. Sadove. 1997. Sperm whale, *Physeter macrocephalus*, sightings in the shallow shelf waters off Long Island, New York. *Mar. Mammal Sci.* 13:317-321.

Schmidly, D. J. 1981. Marine mammals of the southeastern United States and the Gulf of Mexico. Department of the Interior, U.S. Fish and Wildlife Service Publication FWS/OBS-80/41, Washington, DC, 166 pp.

Wade P. R., and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G.T., T. Hamazaki, D. Sheehan, G. Wood, and S. Baker. 2001. Characterization of beaked whale (Ziphiidae) and sperm whale (*Physeter macrocephalus*) summer habitat in shelf-edge and deeper waters off the northeast U.S. *Mar. Mammal Sci*. 17(4): 703-717.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES. C.M.* 1992/N:12. 29 pp.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1993. Sperm whales associated with Gulf Stream features off the northeastern USA shelf. *Fish. Oceanogr. 2:101-105*

Waring, G. T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA-NMFS-NEFSC, Lab. Ref. Doc. No. 98-09, 21 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Watkins, W. A., K. E. Moore and P. Tyack. 1985. Sperm whale acoustic behavior in the southeast Caribbean. *Cetology* 49:1-15.

Watkins, W. A., M. A. Daher, K. M. Fristrup and T. J. Howald. 1993. Sperm whales tagged with transponders and tracked underwater by sonar. *Mar. Mammal Sci.* 9:55-67.

Whitehead, H. 2003. Sperm whales social evolution in the ocean. The *University of Chicago Press,* Chicago, 431 pp.

Whitehead, H., S. Brennan and D. Grover. 1991. Distribution and behavior of male sperm whales on the Scotian Shelf, Canada. *Can. J. Zool.* 70:912-918.

November 2004

LONG-FINNED PILOT WHALE (*Globicephala melas*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of pilot whales in the Western Atlantic — the Atlantic or long-finned pilot whale, *Globicephala melas*, and the short-finned pilot whale, *G. macrorhynchus*. These species are difficult to identify to the species level at sea; therefore, some of the descriptive material below refers to *Globicephala* sp., and is identified as such. The species boundary is considered to be in the New Jersey to Cape Hatteras area. Sightings north of this area are likely *G. melas*.

Pilot whales (*Globicephala* sp.) are distributed principally along the continental shelf edge in the winter and early spring off the northeast U.S. coast, (CETAP 1982; Payne and Heinemann 1993; Abend and Smith 1999). In late spring, pilot whales move onto Georges Bank and into the Gulf of Maine and more northern waters, and remain in these areas through late autumn (CETAP 1982; Payne and Heinemann 1993). In general, pilot whales occupy areas of high relief or submerged banks. They are also associated with the Gulf Stream north wall and thermal fronts along the continental shelf edge (Waring *et al.* 1992; NMFS unpublished data).

The long-finned pilot whale is distributed from North Carolina to North Africa (and the Mediterranean) and north to Iceland, Greenland and the Barents Sea (Sergeant 1962; Leatherwood *et al.* 1976; Abend 1993; Buckland *et al.* 1993; Abend and Smith 1999). The stock structure of the North Atlantic population is uncertain (Anon. 1993a; Fullard *et al.* 2000). Recent morphometrics (Bloch and Lastein 1993) and genetics (Siemann 1994; Fullard *et al.* 2000) studies have provided little support for stock structure across the Atlantic (Fullard *et al.* 2000). However, Fullard *et al.* (2000) have proposed a stock structure that is correlated to sea surface temperature: 1) a cold-water population west of the Labrador/North Atlantic current, and 2) a warm-water population that extends across the Atlantic in the Gulf Stream.

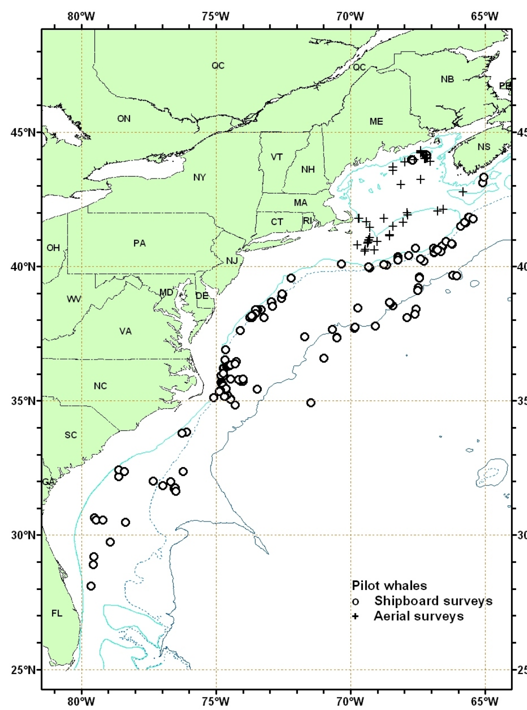

Figure 1. Distribution of pilot whales sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1998, 1999, and 2004. Isobaths are at 100 m, 1,000 m, and 4,000 m.

POPULATION SIZE

The total number of long-finned pilot whales off the eastern U.S. and Canadian Atlantic coast is unknown, although several estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). Two estimates were derived from catch data and population models that estimated the abundance of the entire stock. Seasonal estimates are available from selected regions in U.S. waters during spring, summer and autumn 1978-1982, August 1990, June-July 1991, August-September 1991, June-July 1993, July-September 1995, July-August 1998, and June-August 2004. Because long-finned and short-finned pilot whales are difficult to identify at sea, seasonal abundance estimates were reported for *Globicephala* sp., both long-finned and short-finned pilot whales. One estimate is available from the Gulf of St. Lawrence.

Mitchell (1974) used cumulative catch data from the 1951-1961 drive fishery off Newfoundland to estimate the initial population size (ca. 50,000 animals).

Mercer (1975), used population models to estimate a population in the same region of between 43,000 and 96,000 long-finned pilot whales, with a range of 50,000-60,000 being considered the best estimate.

An abundance of 11,120 (CV=0.29) *Globicephala* sp. was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 3,636 (CV=0.36) *Globicephala* sp. was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). Abundances of 3,368 (CV=0.28) and 5,377 (CV=0.53) *Globicephala* sp. were estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11 aircrafts, respectively (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than 8 years are deemed unreliable, and therefore should not be used for PBR determinations. Further, due to changes in survey methodology, these data should not be used to make comparisons to more current estimates.

An abundance of 668 (CV=0.55) *Globicephala* sp. was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Anon. 1993b). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for *g(0),* the probability of detecting a group on the track line, or for dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 8,176 (CV=0.65) *Globicephala* sp. was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Palka *et al.* Unpub. Ms.). Total track line length was 32,600km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom isobath. Data collection and analysis methods used were described in Palka (1996).

Kingsley and Reeves (1998) obtained an abundance estimate of 1,600 long-finned pilot whales (CV=0.65) from a late August and early September aerial survey of cetaceans in the Gulf of St. Lawrence in 1995 and 1998 (Table 1). Based on an examination of long-finned pilot whale summer distribution patterns and information on stock structure, it was deemed appropriate to combine these estimates with NMFS 1995 summer survey data. The best 1995 abundance estimate for *Globicephala* sp. is 9,776 (CV=0.55), the sum of the estimates from the U.S. and Canadian surveys, where the estimate from the U.S. survey is 8,176 (CV=0.65) and from the Canadian 1,600 (CV=0.65).

An abundance of 9,800 (CV=0.34) *Globicephala* sp. was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900km of track line in waters north of Maryland (38° N) (Figure 1; Table 1; Palka *et al.* Unpub. Ms.). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)*.

An abundance of 5,109 (CV = 0.41) *Globicephala* sp. was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 54,163 km of track line in waters south of Maryland (38°N) (Figure 1; Mullin and Fulling 2003). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) where school size bias and ship attraction were accounted for.

The best 1998 abundance estimate for *Globicephala* sp. is 14,909 (CV = 0.26), the sum of the estimates from the two U.S. Atlantic surveys, where the estimate from the northern U.S. Atlantic is 9,800 (CV=0.34) and from the southern U.S. Atlantic is 5,109 (CV =0.41). This estimate is a recalculation of the same data reported in previous SARs. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

An abundance of 15,436 (CV=0.325) for *Globicephala* sp. was estimated from a line transect sighting survey conducted during June 12 to August 4, 2004 by a ship and plane that surveyed 10,761 km of track line in waters north of Maryland (about 38° N) to the Bay of Fundy (about 45° N) (Figure 1; Palka unpubl.). Shipboard data were collected using the two independent team line transect method and analyzed using the modified direct duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and g(0), the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line transect method (Hiby 1999) and analyzed accounting for g(0) and biases due to school size and other potential covariates (Figure 1; Palka Unpubl.).

A shipboard survey of the U.S. Atlantic outer continental shelf and continental slope (water depths ≥ 50m) between Florida and Maryland (27.5 and 38ºN latitude) was conducted during June-August, 2004. The survey employed two independent visual teams searching with 50x bigeye binoculars. Survey effort was stratified to include increased effort along the continental shelf break and Gulf Stream front in the mid-Atlantic. The survey included 5,659 km of trackline, and there were a total of 473 cetacean sightings. Sightings were most frequent in waters north of Cape Hatteras, North Carolina along the shelf break. Data were analyzed to correct for visibility bias (*g(0)*) and group-size bias employing line transect distance analysis and the direct duplicate estimator (Palka, 1995; Buckland *et al.*, 2001). The resulting abundance estimate for *Globicephala* sp. between Florida and Maryland was 15,411 (CV =0.428).

The best 2004 abundance estimate for *Globicephala* sp. is the sum of the estimates from the two 2004 U.S. Atlantic surveys, 30,847 (CV =0.269), where the estimate from the northern U.S. Atlantic is 15,436 (CV =0.325) , and from the southern U.S. Atlantic is 15,411 (CV =0.428). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Table 1. Summary of abundance estimates for the western North Atlantic *Globicephala* sp. by month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	9,800	0.34
Jul-Aug 1998	Florida to Maryland	4,7245, 5,109	0. 0.41
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	14,909	0.26
Jun-Aug 2004	Maryland to the Bay of Fundy	15,436	0.33
Jun-Aug 2004	Florida to Maryland	15,411	0.43
Jun-Aug 2004	Bay of Fundy to Florida	30,847	0.27

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for *Globicephala* sp. is 30,847 (CV = 0.27) The minimum population estimate for *Globicephala* sp. is 24,697.

Current Population Trend

There are insufficient data to determine the population trends for *Globicephala* sp..

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include those from animals taken in the Newfoundland drive fishery: calving interval 3.3 years; lactation period about 21-22 months; gestation period 12 months; births mainly from June to November; length at birth is 177cm; mean length at sexual maturity is 490cm for males and 356cm for females; age at sexual maturity is 12 years for males and 6 years for females; mean adult length is 557cm for males and 448cm for females; and maximum age was 40 for males and 50 for females (Sergeant 1962; Kasuya *et al.* 1988). Analysis of data recently collected from animals taken in the Faroe Islands drive fishery produced higher values for all parameters (Bloch *et al.* 1993; Desportes *et al.* 1993; Martin and Rothery 1993). These differences are likely related, at least in part, to larger sample sizes and newer analytical techniques.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for *Globicephala* sp. is 24,697. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.50 because the CV of the average mortality estimate is less than 0.3 (Wade and Angliss 1997) and because this stock is of unknown status. PBR for the western North Atlantic *Globicephala* sp. is 247.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Detailed fishery information are reported in Appendix III. Total fishery-related mortality and serious injury cannot be estimated separately for the two species of pilot whales in the U.S. Atlantic EEZ because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that either species might have been subject to the observed fishery-related mortality and serious injury. Total annual estimated average fishery-related mortality or serious injury to *Globicephala* sp. during 1999-2003 in the U.S. fisheries listed below was 201pilot whales (CV =0.40) (Table 2).

EARLIER INTERACTIONS

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the U.S.. A fishery observer program, which has collected fishery data and information on incidental bycatch of marine mammals, was established in 1977 with the implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA). Foreign fishing operations for squid ceased at the end of the 1986 fishing season and, for mackerel, at the end of the 1991 fishing season.

During 1977-1991, observers in this program recorded 436 pilot whale mortalities in foreign-fishing activities (Waring *et al.* 1990; Waring 1995). A total of 391 (90%) were taken in the mackerel fishery, and 41 (9%) occurred during *Loligo* and *Illex* squid-fishing operations. This total includes 48 documented takes by U.S. vessels involved in joint-venture fishing operations in which U.S. captains transfer their catches to foreign processing vessels. Due to temporal fishing restrictions, the bycatch occurred during winter/spring (December to May) in continental shelf and continental shelf edge waters (Fairfield *et al.* 1993; Waring 1995); however, the majority of the takes occurred in late spring along the 100m isobath. Two animals were also caught in both the hake and tuna longline fisheries (Waring *et al.* 1990).

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, pelagic pair trawl, bluefin tuna purse seine, North Atlantic bottom trawl, Atlantic squid, mackerel, butterfish trawl, and mid-Atlantic coastal gillnet fisheries, but no mortalities or serious injuries have been documented in the Northeast sink gillnet fishery.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (*i.e.*, permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch from 1989 to 1993 were obtained using the aggregated (pooled 1989-1993) catch rates, by stratum (Northridge 1996). Estimates of total annual bycatch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fisheries information. Variances were estimated using bootstrap re-sampling techniques. Between 1989 and 1998, 87 mortalities were observed in the large pelagic drift gillnet fishery. The annual fishery-related mortality (CV in parentheses) was 77 in 1989 (0.24), 132 in 1990 (0.24), 30 in 1991 (0.26), 33 in 1992 (0.16), 31 in 1993 (0.19), 20 in 1994 (0.06), 9.1 in 1995 (0), 11 in 1996 (.17), no fishery in 1997 and 12 in 1998 (0). Since this fishery no longer exists it has been excluded from Table 2. Pilot whales were taken along the continental shelf edge, northeast of Cape Hatteras in January and February. Takes were recorded at the continental shelf edge east of Cape Charles, Virginia, in June. Pilot whales were taken from Hydrographer Canyon along the Great South Channel to Georges Bank from July to November. Takes occurred at the Oceanographer Canyon continental shelf break and along the continental shelf northeast of Cape Hatteras in October-November.

Pelagic Pair Trawl

The pelagic pair trawl fishery operated as an experimental fishery from 1991 to 1995.This fishery ceased operations in 1996 when NMFS rejected a petition to consider pair trawl gear as an authorized gear type in the Atlantic tunas fishery.etal.*et al.* Five pilot whale (*Globicephala* sp.) mortalities were reported in the self-reported fisheries information in 1993. In 1994 and 1995 observers reported 1 and 12 mortalities, respectively. The estimated fishery-related mortality to pilot whales in the U.S. Atlantic attributable to this fishery in 1994 was 2.0 (CV=0.49) and 22 (CV=0.33) in 1995. Since this fishery no longer exists, it has been excluded from Table 2.

During the 1994 and 1995 experimental fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudey 1995, 1996), but the results were inconclusive.

Pelagic Longline

Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, from 1991 to 2000 (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999; Yeung 1999a; Yeung *et al.* 2000). In the 2001 Stock Assessment Report, the annual effort has been recalculated to include those sets targeting other species in conjunction with tuna/swordfish, instead of just effort that exclusively targeted tuna/swordfish as in previous reports (Johnson *et al.* 1999; Yeung 1999a) *et al.* The fishery has been observed from January to March off Cape Hatteras, in May and June in the entire mid-Atlantic, and in July through December in the mid-Atlantic Bight and off Nova Scotia. Most of the estimated marine mammal bycatch was from U.S. Atlantic EEZ waters between South Carolina and Cape Cod (Johnson *et al.* 1999). Pilot whales are frequently observed to feed on hooked fish, particularly big-eye tuna (NMFS unpublished data). Between 1992 and 2000, 62 pilot whales (including 2 identified as a short-finned pilot whales) were released alive, including 32 that were considered seriously injured (of which 1 was identified as a short-finned pilot whale), and 2 mortalities were observed. January-March bycatch was concentrated on the continental shelf edge northeast of Cape Hatteras. Bycatch was recorded in this area during April-June, and takes also occurred north of Hydrographer Canyon off the continental shelf in water over 1,000 fathoms during April-June. During the July-September period, takes occurred on the continental shelf edge east of Cape Charles, Virginia, and on Block Canyon slope in over 1,000 fathoms of water. October-December bycatch occurred between the 20 and 50 fathom contour lines between Barnegat Bay and Cape Hatteras. The estimated fishery-related mortality to pilot whales in the U.S. Atlantic (excluding the Gulf of Mexico) attributable to this fishery was: 127 in 1992 (CV=1.00), 93 in 1999 (CV=1.00), 24 in 2000 (CV=1.0), 20 (CV = 1.0) in 2001, 2 (CV =1.0) in 2002 and 0 in 2003. The estimated serious injuries were 40 (CV=0.71) in 1992, 19 (CV=1.00) in 1993, 232 (CV=0.53) in 1994, 345 (CV= 0.51) in 1995, (includes 37 estimated short-finned pilot whales in 1995 (CV=1.00), 0 from 1996 to 1998, 288 (CV=0.74) in 1999, 109 (CV=1.0) in 2000, 50 in 2001, 52 in 2002, and 21 in 2003. The average 'combined' annual mortality in 1999-2003was132 pilot whales (CV =0.49) (Table 2).

Bluefin Tuna Purse Seine

The tuna purse seine fishery between Cape Hatteras and Cape Cod is directed at small and medium bluefin and skipjack for the canning industry, while north of Cape Cod, purse seine vessels are directed at large medium and giant bluefin tuna (NMFS 1995). Two interactions with pilot whales were observed in 1996. In one interaction, the net was actually pursed around one pilot whale, the rings were released and the animal escaped alive, condition unknown. This set occurred east of the Great South Channel and just north of the Cultivator Shoals region on Georges Bank. In a second interaction, 5 pilot whales were encircled in a set. The net was opened prior to pursing to let the whales swim free, apparently uninjured. This set occurred on the Cultivator Shoals region on Georges Bank. Since 1996, this fishery has not been observed.

Southern New England/Mid-Atlantic Squid, Mackerel, Butterfish Trawl Fisheries

Because of spatial and temporal differences in the harvesting of *Illex* and *Loligo* squid, and Atlantic mackerel, each one of these sub-fisheries are described separately. The *Illex* and *Loligo* squid fisheries are managed by moratorium permits, gear and area restrictions, quotas, and trip limits. The Atlantic mackerel and butterfish fisheries are managed by an annual quota system.

Historically, the mid-Atlantic mackerel and squid trawl fisheries were combined into the Atlantic mid-water trawl fishery in the revised proposed list of fisheries in 1995. The mackerel trawl fishery was classified as a Category II fishery since 1990 and the squid fishery was originally classified as a Category II fishery in 1990, but was reclassified as a Category III fishery in 1992. The combined fishery was then reclassified as a Category II fishery in 1995.

Illex Squid

The U.S. domestic fishery, ranging from Southern New England to Cape Hatteras North Carolina, reflects patterns in the seasonal distribution of *Illex* squid (*Illex illecebrosus*). *Illex* are harvested offshore mainly by small mesh otter trawlers when they are distributed in continental shelf and slope waters during the summer months (June-September)(Clark ed. 1998). Since 1996, 45% of all pilot whale takes observed were caught incidental to *Illex* squid fishing operations; 1 in 1996, 1 in 1998 and 2 in 2000. Annual observer coverage of this fishery has varied widely and reflects only the months when the fishery is active. The estimated fishery-related mortality of pilot whales attributable to this fishery was: 45 in 1996 (CV=1.27), 0 in 1997, 85 in 1998 (CV=0.65), 0 in 1999, 34 in 2000 (CV=0.65), unk in 2001-2002 due to no observer coverage, and 0 in 2003 . The average annual mortality between 1999-2003 was 11 pilot whales (CV=0.65) (Table 2).

Loligo Squid

The U.S. domestic fishery for *Loligo* squid (*Loligo pealeii*) occurs mainly in Southern New England and mid-Atlantic waters. Fishery patterns reflect *Loligo* seasonal distribution where most effort is directed offshore near the edge of the continental shelf during the fall and winter months (October-March), and inshore during the spring and summer months (April-September) (Clark ed. 1998). This fishery is dominated by small-mesh otter trawlers, but substantial landings are also taken by inshore pound nets and fish traps during the spring and summer months (Clark ed. 1998). Only one pilot whale incidental take has been observed in *Loligo* squid fishing operations since 1996. The one take was observed in 1999 in the offshore fishery. No pilot whale takes have been observed in the inshore fishery. The estimated fishery-related mortality of pilot whales attributable to the fall/winter offshore fishery was 0 between 1996 and 1998, 49 in 1999 (CV=0.97) and 0 between 2000 and 2003 . The average annual mortality between 1999-2003 was 10 pilot whales (CV=0.97) (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

Atlantic Mackerel

The U.S. domestic fishery for Atlantic mackerel (*Scomber scombrus*) occurs primarily in the Southern New England and mid-Atlantic waters between the months of January and May (Clark ed. 1998). This fishery is dominated by mid-water (pelagic) trawls. No incidental takes of pilot whales have been observed in the domestic mackerel fishery.

A U.S. joint venture (JV) fishery was conducted in the mid-Atlantic region from February to May 1998. NMFS maintained 100% observer coverage of the foreign joint venture vessels where 152 transfers from the U.S. vessels were observed. No incidental takes of pilot whales have been observed in the mackerel fishery. The former distant water fleet fishery has been non-existent since 1977. There is also a mackerel trawl fishery in the Gulf of Maine that generally occurs during the summer and fall months (May-December) (Clark ed. 1998). There have been no observed incidental takes of pilot whales reported for the Gulf of Maine fishery.

Southern New England/Mid-Atlantic Bottom Trawl Fisheries

This fishery occurs year round, ranging from Cape Cod Massachusetts to Cape Hatteras North Carolina. It represents a variety of individual sub-fisheries that include but are not limited to; monkfish, summer flounder (fluke), winter flounder, silver hake (whiting), spiny and smooth dogfish, scup, and black sea bass. There was one observed take in this fishery reported in 1999. The estimated fishery-related mortality for pilot whales attributable to this fishery was: 0 in 1996-1998, 228 in 1999 and 0 in 2000-2003. The average annual mortality between 1999-2003 was 46 pilot whales (CV=1.03) (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

Northeast Atlantic (Gulf of Maine/Georges Bank) Herring Fishery

There were no marine mammal takes observed from the domestic mid-water trawl fishing trips during .

A U.S. joint venture (JV) mid-water (pelagic) trawl fishery was conducted on Georges Bank from August - December 2001. A Total Allowable Level of Foreign Fishing (TALFF) was also granted during the same time period. Eight pilot whales were incidentally captured in a single mid-water trawl during JV fishing operations. Three pilot whales were incidentally captured in a single mid-water trawl during foreign fishing operations (TALFF) (Table 2). The 1999-2003 average mortality attributed to the Atlantic herring mid-water trawl fishery was 2 animals (Table 2).

Mobile Gear Restricted Areas

Mobile gear restricted areas (GRA's) were put in place for fishery management purposes in November 2000. The intent of the GRA is to reduce bycatch of scup. The GRA's are spread out in time and space along the edge of the Southern New England and mid-Atlantic continental shelf region (between 100-1000 meters). These seasonal closures are targeted at trawl gear with small mesh sizes (<4.5 inches). The Atlantic herring and Atlantic mackerel trawl fisheries are exempt from the GRA's. A temporary exemption was also granted for the *Loligo* squid fishery. For detailed information regarding GRA's refer to FR/Vol. 66, No. 41.

Mid-Atlantic Coastal Gillnet

This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. No pilot whales were taken in observed trips during 1993-1997. One pilot whale was observed taken in 1998, 0 during 1999-2003 (Table 2). Observed effort was scattered between New York and North Carolina from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 7 in 1998 (1.1). Average annual estimated fishery-related mortality attributable to this fishery between 1999-2003 was zero pilot whale.

CANADA

An unknown number of pilot whales have also been taken in Newfoundland and Labrador, and Bay of Fundy groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, and Atlantic Canada cod traps (Read 1994).

Between January 1993 and December 1994, 36 Spanish deep-water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211 sets), were observed in NAFO Fishing Area 3 (off the Grand Banks) (Lens 1997). A total of 47 incidental catches were recorded, which included 1 long-finned pilot whale. The incidental mortality rate for pilot whales was 0.007/set.

In Canada, the fisheries observer program places observers on all foreign fishing vessels, on between 25% and 40% of large Canadian vessels (greater than 100ft), and on approximately 5% of small vessels (Hooker *et al.* 1997). Fishery observer effort off the coast of Nova Scotia during 1991-1996 varied on a seasonal and annual basis, reflecting changes in fishing effort (see Figure 3, Hooker *et al.* 1997). During the 1991-1996 period, long-finned pilot whales were bycaught (number of animals in parentheses) in bottom trawl (65); midwater trawl (6); and longline (1) gear. Recorded bycatches by year were: 16 in 1991, 21 in 1992, 14 in 1993, 3 in 1994, 9 in 1995 and 6 in 1996. Pilot whale bycatches occurred in all months except January-March and September (Hooker *et al.* 1997).

Table 2. Summary of the incidental mortality and serious injury of pilot whales (*Globicephala sp.*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the observed mortalities and serious injuries recorded by on-board observers, the estimated annual mortality and serious injury, the combined annual estimates of mortality and serious injury (Estimated Combined Mortality), the estimated CV of the combined estimates (Estimated CVs) and the mean of the combined estimates (CV in parentheses).

Fishery	Years	Vessels[4]	Data Type [1]	Observer Coverage[2]	Observed Serious Injury	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Estimated Combined Mortality	Estimated CVs	Mean Annual Mortality
SNE/mid-Atlantic Illex Squid Trawl	99-03	73 [5]	Obs. Data Dealer	.028, .111, .00, .00, tbd	0, 0, unk, unk, 0	0, 2, unk, unk, 0	0, 0, unk, unk, 0	0 34, unk, unk, 0	0 34, unk, unk, 0	0, 0.65, unk, unk, 0	11 (.65)
SNE/mid-Atlantic Loligo Squid Trawl (offshore)	98-02 99-03	384 [5]	Obs. Data Dealer	.009, .011, .012, .005, tbd	0, 0, 0, 0, 0	1, 0, 0, 0, 0	0, 0, 0, 0, 0	49, 0, 0, 0, 0	49, 0, 0, 0, 0	0.97, 0, 0, 0, 0	10 (0.97)
SNE/ mid-Atlantic Bottom Trawl	98-02 99-03	NA	Obs. Data Dealer	.003, .003, .004, .005, tbd	0, 0, 0, 0, 0	1[6], 0, 0, 0, 0	0, 0, 0, 0, 0	228, 0, 0, 0, 0	228, 0, 0, 0, 0	1.03, 0, 0, 0, 0	46 (1.03)
GOM/GB Herring Mid-Water Trawl JV and TALFF[9]	98-02 99-03	1999-2000=0 2001=10[8] 2002-2003=0	Obs. Data	NA, NA 1.00[7], NA, NA	0, 0, 0, 0, 0	0, 0, 11, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 11, 0, 0	0, 0, 0, 11, 0, 0	NA	2 (NA)
Pelagic[3] Longline (excluding NED-E) [10]	98-02 99-03	205, 193, 70, 54, 21	Obs. Data Logbook	.04, .04, .02, .04, .02	4, 4, 4, 4, 2	1, 1, 1, 0, 0	288, 109, 50, 52, 21	93, 24, 20, 2, 0	381,133, 70, 54, 21	.79, .88, .50, .46, .77	132 (0.49)
Pelagic Longline - NED-E area only [3, 10]	2001-2003	180 sets, 482, 535	Obs. Data Logbook	1, 1, 1	0, 0,0	0,0,0	0,0,0	0,0,0	0,0,0	0	0
Mid-Atlantic Coastal Gillnet	98-02 99-03	NA	Obs. Data Dealer	.05, .02,.02, .02, .01, .01	0, 0, 0, 0, 0	1, 0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, unk[11], 0	0, 0, 0, unk[11], 0	0, 0, 0, unk[11], 0	0 (0)
TOTAL											201 (0.40)

[1] Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook data were used to measure total effort for the longline fishery. These data are collected at the Southeast Fisheries Science Center (SEFSC).

[2] Observer coverage of the mid-Atlantic coastal gillnet fishery is measured in tons of fish landed. Observer coverage for the longline fishery are in terms of sets. The trawl fisheries are measured in trips.

[3] 1997-1998 mortality estimates were taken from Table 9a in Yeung et al. (NMFS Miami Laboratory PRD 99/00-13), and excludes the Gulf of Mexico. 1999-2000 mortality estimates were taken from Table 10 in Yeung 2000 (NOAA Technical Memorandum NMFS-SEFSC-467).

[4] Number of vessels in the fishery are based on vessels reporting effort to the pelagic longline logbook.

[5] These are numbers of potential fishing vessels based on permit holders in the 2002 fishery. Many of these vessels participate in the other fisheries and therefore the reported number of vessels are not additive across the squid, mackerel and butterfish fisheries. (67FR 65937).

[6] The incidental take was observed on a trip than landed silver hake as the primary species.

[7] During joint venture fishing operations, nets that are transferred from the domestic vessel to the foreign vessels for processing are observed on board the foreign vessel. There may be nets fished by domestic vessels that do not get transferred to a foreign vessel for processing and therefore would not be observed. During TALFF fishing operations all nets fished by the foreign vessel are observed.

[8] Three foreign vessels and seven American vessels.

[9] NA=No joint venture or TALFF fishing effort for Atlantic herring.

[10] An experimental program to test effects of gear characteristics, environmental factors, and fishing practices on marine turtle bycatch rates in the Northeast Distant (NED-E) water component of the fishery was conducted from June 1, 2001-December 31, 2003. Observer coverage was 100% during this experimental fishery. Summaries are provided for the pelagic longline EXCLUDING the NED-E area in one row and for ONLY the NED in the second row. No mortalities nor serious injuries were observed for pilot whales in the NED-E, though 1 pilot whale was caught alive and released without injury (Garrison, 2003; Garrison and Richards, 2004).

[11] Sixty-five percent of sampling in the mid-Atlantic coastal gillnet by the NEFSC fisheries observer program was concentrated in one area off the coast of virginia. Because of the low level of sampling that was not distributed proportionately throughout the mid-Atlantic region observed mortality is considered unknown in 2002. The previous five four year average (1999-2001, and 2003) estimated mortality was applied as the best representative estimate.

Other Mortality

Pilot whales have a propensity to mass strand throughout their range, but the role of human activity in these events is unknown. Between 2 and 120 pilot whales have stranded annually, either individually or in groups, in NMFS Northeast Region (Anon. 1993b) since 1980. From 1999-2003 126 pilot whales (*Globicephala sp.*) have been reported stranded between Maine and Florida (Table 3), including 11 and 57 animals that mass stranded in 2000 and 2002, respectively along the Massachusetts coast (NMFS unpublished data). Two juvenile animals that live stranded in Chatham, Massachusetts in 1999 were rehabilitated, satellite tagged and released (Nowojchik *et at.* 2003). Both animals were released off eastern Long Island, NY and tracked for four months in the Gulf of Maine. Four of 6 animals from one live stranding event in Massachusetts in 2000 were rehabilitated and released. In addition, 11 pilot whales that live stranded on Nantucket were returned to the water. However, certain studies have shown that frequently, animals that are returned to the water swim away and strand someplace else (Fehring and Wells 1976; Irvine *et al.* 1979; Odell *et al.* 1980)

Short-finned pilot whales (*Globicephala macrorhynchus*) have been reported stranded as far north as Block Island, Rhode Island (2001) and long-finned pilot whales (*Globicephala melas*) as far south as South Carolina. Rarely is there a distinction made between these two species within the U.S. east coast regional stranding records.

In eastern Canada, 37 strandings of long-finned pilot whales (173 individuals) were reported on Sable Island, Nova Scotia from 1970 to 1998 (Lucas and Hooker 1997; Lucas and Hooker 2000). This included 130 animals that mass stranded in December 1976, and 2 smaller groups (<10 each) in autumn 1979 and summer 1992. Fourteen strandings were also recorded along Nova Scotia in 1991-1996 (Hooker *et al.* 1997).

Table 3. Pilot Whale (*Globicephala sp.*) strandings along the U.S. Atlantic coast 1999-2003. No distinction has been made between short-finned (*Globicephala macrorhynchus*) and long-finned pilot whale (*G. melas*).

State	1999	2000	2001	2002	2003	TOTALS
Maine	0	0	5	2	1	8
New Hampshire	0	0	0	0	0	0
Massachusetts[1]	6	13	3	67	5	94
Rhode Island	0	0	1	1	0	2
Connecticut	0	0	0	0	0	0
New York	1	1	1	0	0	3
New Jersey	1	0	0	0	6	7
Delaware	0	0	0	0	0	0
Maryland	1	0	0	0	0	1
Virginia	2	0	0	0	0	2
North Carolina	2	0	2	0	0	4
South Carolina	0	0	1	0	1[4]	2
Georgia	0	1	0	0	0	1
Florida[2]	2	0	0	0	0	2
TOTALS	15	15	13	70	13	126

[1] Massachusetts mass stranding (11- animals, July 2000; 57 - animals, July 2002)

[4] Only moderate confidence on species identification

A potential human-caused source of mortality is from polychlorinated biphenyls (PCBs) and chlorinated pesticides (DDT, DDE, dieldrin, etc.), moderate levels of which have been found in pilot whale blubber (Taruski 1975; Muir *et al.* 1988; Weisbrod *et al.* 2000). Weisbrod *et al.* (2000) reported that bioaccumulation levels were more similar in whales from the same standing group than animals of the same sex or age. Also, high levels of toxic metals (mercury, lead, cadmium) and selenium were measured in pilot whales harvested in the Faroe Islands drive fishery (Nielsen *et al.* 2000). Similarly, Dam and Bloch (2000) found very high PCB levels in pilot whales in the Faroes. The population effect of the observed levels of such contaminants is unknown.

STATUS OF STOCK

The status of long-finned pilot whales relative to OSP in U.S. Atlantic EEZ is unknown, but stock abundance may have been affected by reduction in foreign fishing, curtailment of the Newfoundland drive fishery for pilot whales in 1971, and increased abundance of herring, mackerel and squid stocks. There are insufficient data to determine the population trends for this species. The species is not listed under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because the 1999-2003 estimated average annual fishery-related mortality, excluding Nova Scotia bycatches of pilot whales, *Globicephala* sp., does not exceed PBR. The status has gone back and forth, because mortality has been close to PBR. In the last six editions of this stock assessment report, it has been designated as non-strategic in 1998, and 1999.

REFERENCES

Abend, A. 1993. Long-finned pilot whale distribution and diet as determined from stable carbon and nitrogen ratio isotope tracers. MS Thesis, University of Massachusetts, Amherst, MA.

Abend, A. and T.D. Smith. 1999. Review of the distribution of the long-finned pilot whale (*Globicephala melas*) in the North Atlantic and Mediterranean. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-NE-117, 22 pp.

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA-NMFS-SEFSC and NEFSC. 4 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1993a. Report of the study group on long-finned pilot whales. *ICES* C.M. 1993/N:5 29 pp.

Anon. 1993b. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. 5 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1993c. Status of fishery resources off the northeastern United States for 1993. U. S. Dep. Commer., NOAA Tech. Mem. NMFS-F/NEC-101, 140 pp.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bloch, D. and L. Lastein. 1993. Morphometric segregation of long-finned pilot whales in eastern and western North Atlantic. *Ophelia*, 38: 55-68.

Bloch, D., M. Zachariassen and P. Zachariassen. 1993. Some external characters of the long-finned pilot whale off Faroe Island and a comparison with the short-finned pilot whale. *Rep. int Whal. Commn.* Special Issue 14:117-135.

Buckland, S. T., D. R. Anderson, K. P. Burnham and S. L. Laake. 1993. *Distance sampling: estimating abundance of biological populations. (Chapman and Hall)*, New York, NY, 446 pp.

Buckland, S. T., D. Bloch, K. L. Cattanach, Th. Gunnlaugsson, K. Hoydal, S. Lens, and J. Sigurjónsson. 1993. Distribution and abundance of long-finned pilot whales in the North Atlantic, estimated from NASS-87 and NASS-89 data. *Rep. int Whal. Commn*. (Special Issue 14): 33-49.

Buckland, S. T., D.R. Andersen, K.P Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling estimating abundance of biological populations. *Oxford University Press*, New York, 432 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Cramer J. 1994. Large pelagic logbook newsletter - 1993. U. S. Dep. Commer., NOAA Tech. Mem. NMFS-SEFSC-352, NMFS, Southeast Fisheries Science Center, Miami, FL. 19 pp.

Dam, M. and D. Bloch. 2000. Screening of mercury and persistent organochlorine pollutants in long-finned pilot whale (*Globicephala melas*) in the Faroe Islands. *Mar. Pollut. Bull.* 40: 1090-1099.

Desportes, G., M. Saboureau and A. Lacroix. 1993. Reproductive maturity and seasonality of male pilot long-finned whales off the Faroe Islands. *Rep. int Whal. Commn*. (Special Issue 14): 233-262.

Fairfield, C. P., G. T. Waring and M. H. Sano. 1993. Pilot whales incidentally taken during the distant water fleet Atlantic mackerel fishery in the mid-Atlantic Bight, 1984-88. *Rep. int Whal. Commn*. (Special Issue 14): 107-116.

Fehring, W. K. and R. S. Wellsw. 1976. A series of strandings by a single heard of pilot whales on the west coast of Florida. *J. Mamm*. 57(1): 191-194.

Fullard, K. J., G. Early, M. P. Heide-Jørgensen, D. Bloch, A. Rosing-Asvid, and W. Amos. 2000. Population structure of long-finned pilot whales in the North Atlantic: a correlation with sea surface temperature? *Molecular Ecol*. 9: 949-958.

Gerrior, P., A. S. Williams and D. J. Christensen. 1994. Observations of the 1992 U.S. pelagic pair trawl fishery in the Northwest Atlantic. *Mar. Fish. Rev*. 56(3): 24-27.

Goudey, C. A. 1995 . The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 10 pp.

Goudey, C. A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, MITSG 96-17, Cambridge, MA. 13 pp.

Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 *in*: Garner *et al.* (eds). Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.

Hooker, S. K., R. W. Baird and M. A. Showell. 1997. Cetacean Strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Paper SC/49/05 presented to the IWC Scientific Committee, September 1997. 11 pp.

Irvine, A. B., M.. D. Scott, R. S. Wells, and J. G. Mead. 1979. Stranding of the pilot whale, *Globicephala macrorhynchus*, in Florida and South Carolina. *Fish. Bull.*, U.S. 77 (2): 511-513.

Johnson, D. R., C. A. Brown and C. Yeung. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC-418. 70 pp. NMFS, Southeast Fisheries Science Center, Miami, FL.

Kasuya, T., D. E. Sergeant and K. Tanaka. 1988. Re-examination of life history parameters of long-finned pilot whales in the Newfoundland waters. *Sci. Rep. Whales Res. Inst.* No. 39: 103-119.

Kingsley, M.C.S. and R.R. Reeves. 1998. Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. *Can. J. Zool*. 76: 1529-1550.

Laake, J. L., S. T. Buckland, D. R. Anderson and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Ft. Collins, CO. 72 pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dep. Commer., NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. ICES CM 1997/Q:8. 10 pp.

Lucas, Z. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Paper SC/49/06 presented to the IWC Scientific Committee, September 1997. 10 pp.

Lucas, Z. N. and S. K. Hooker. 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. *Can. Field-Nat*. 114: 45-61.

Martin, A. R. and P. Rothery. 1993. Reproductive parameters of female long-finned pilot whales (*Globicephala melas*) around the Faroe Islands. *Rep. int Whal. Commn*. (Special Issue 14): 263-304.

Mercer, M. C. 1975. Modified Leslie-DeLury population models of the long-finned pilot whale (*Globicephala melaena*) and annual production of the short-finned squid (*Illex illecebrosus*) based upon their interactions at Newfoundland. *J. Fish. Res. Bd. Can*. 32(7): 1145-54.

Mitchell, E. 1974. Present status of northwest Atlantic fin and other whale stocks. Pages 108-169 *in:* W. E. Schevill (ed.), *The whale problem*: *A status report*. Harvard University Press, Cambridge, Massachusetts, 419 pp.

Muir, D. C. G., R. Wagermann, N. P. Grift, R. J. Norstrom, M. Simon and J. Lien. 1988. Organochlorine chemical and heavy metal contaminants in white-beaked dolphins (*Lagenorhynchus albirostris*) and pilot whales (*Globicephala melaena*) from the coast of Newfoundland. *Canada. Arch. Environ. Contam. Toxicol.* 17: 613-629.

Mullin, K. D. and G. L. Fulling. 2003. Abundance of cetaceans in the southern U.S. North Atlantic Ocean during summer 1998. *Fish. Bull., U.S.* 101:603-613.

Odell, D. K., E. D. Asper, J. Baucom, and L. H. Cornell. 1980. A recurrent mass stranding of the false killer whale, *Pseudorca crassidens*, in Florida. *Fish. Bull*., U.S. 78(1): 171-177.

Nielsen, J. B., F. Nielsen, P-J. Jørgensen, and P. Grandjean. 2000. Toxic metals and selenium in blood from pilot whales (*Globicephala melas*) and sperm whales (*Physeter catodon*). *Mar. Pollut. Bull*. 40:348-351.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500160.

Nowojchik, R., D. J. St. Aubin, and A. Johnson. 2003. Movements and dive behavior of two stranded, rehabilitated long-finned pilot whales (*Globicephala melas*) in the northwest Atlantic. *Mar. Mamm. Sci.* 19(1):232-239.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. *Rep. int Whal. Commn.* (Special Issue 16): 27-50.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA-NMFS-NEFSC. Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543.

Palka, D. and Hammond, P.S. 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci. 58: 777-787.

Payne, P. M. and D. W. Heinemann. 1993. The distribution of pilot whales (*Globicephala* sp.) in shelf/shelf edge and slope waters of the northeastern United States, 1978-1988. *Rep. int Whal. Commn*. (Special Issue 14): 51-68.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int Whal. Commn.* (Special Issue 15): 133-147.

Scott, G. P. and C. A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1994-1995. Miami Laboratory Contribution MIA-96/97-28.

Sergeant D. E. 1962. The biology of the pilot or pothead whale (*Globicephala melaena* (Traill) in Newfoundland waters. *Bull. Fish. Res. Bd. Can*. 132: 1-84.

Siemann, L. 1994. Mitochondrial DNA sequence variation in North Atlantic long-finned pilot whales, *Globicephala melas*. Ph.D. Thesis, Massachusetts Institute of Technology/ Woods Hole Oceanographic Institution.

Taruski, A. G., C. E. Olney and H. E. Winn. 1975. Chlorinated hydrocarbons in cetaceans. *J. Fish. Res. Bd. Can*. 32(11): 2205-9.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T. 1995. Fishery and ecological interactions for selected cetaceans off the northeast USA. Ph.D. dissertation, University of Massachusetts, Amherst, MA 260 pp.

Waring, G. T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA-NMFS-NEFSC Lab. Ref. Doc. No. 98-09, 21pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull*., U.S. 88(2): 347-360.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. ICES Marine Mammals Comm. CM 1992/N:12, 29 pp.

Waring, G. T., D. L. Palka, P. J. Clapham, S. Swartz, M. C. Rossman, T. V. N. Cole, L. J. Hansen, K. D. Bisack, K. D. Mullin, R. S. Wells, D. K. Odell, and N. B. Barros. 1999. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments — 1999. U.S. Dep. Commer., NOAA Tech. Memo NMFS-NE-153, 196 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543.

Weisbrod, A. V., D. Shea, M. J. Moore, and J. J. Stegeman. 2000. Bioaccumulation patterns of polychlorinated biphenyls and chlorinated pesticides in northwest Atlantic pilot whales. *Environ. Toxicol. Chem*. 19:667-677.

Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC-430, 26 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL, 33149.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC-429, 23 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL, 33149.

Yeung, C., S. Epperly, and C. A. Brown. 2000. Preliminary revised estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet, 1992-1999. NMFS, Miami Lab. PRD Contribution Number 99/00-13, 58 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL, 33149.

Yeung, C. 2001. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1999-2000. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC-467, 43 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL, 33149.

February 2005

WHITE-SIDED DOLPHIN (*Lagenorhynchus acutus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

White-sided dolphins are found in temperate and sub-polar waters of the North Atlantic, primarily in continental shelf waters to the 100m depth contour. The species inhabits waters from central West Greenland to North Carolina (about 35^{o} N) and perhaps as far east as 43^{o} W (Evans 1987). Distribution of sightings, strandings and incidental takes suggest the possible existence of three stocks units: Gulf of Maine, Gulf of St. Lawrence and Labrador Sea stocks (Palka et al. 1997). Evidence for a separation between the well documented unit in the southern Gulf of Maine and a Gulf of St. Lawrence population comes from a hiatus of summer sightings along the Atlantic side of Nova Scotia. This has been reported in Gaskin (1992), is evident in Smithsonian stranding records, and was seen during abundance surveys conducted in the summers of 1995 and 1999 that covered waters from Virginia to the entrance of the Gulf of St. Lawrence. White-sided dolphins were seen frequently in Gulf of Maine waters and in waters at the mouth of the Gulf of St. Lawrence, but only a few sightings were recorded between these two regions.

The Gulf of Maine stock of white-sided dolphins is most common in continental shelf waters from Hudson Canyon (approximately 39°N) north through Georges Bank, and in the Gulf of Maine to the lower Bay of Fundy. Sightings data indicate seasonal shifts in distribution (Northridge et al. 1997). During January to May, low numbers of white-sided dolphins are found from Georges Bank to Jeffreys Ledge (off New Hampshire), and even lower numbers are south of Georges Bank, as documented by a few strandings collected on beaches of Virginia and North Carolina. From June through September, large numbers of white-sided dolphins are found from Georges Bank to lower Bay of Fundy. From October to December, white-sided dolphins occur at intermediate densities from southern Georges Bank to southern Gulf of Maine (Payne and Heinemann 1990). Sightings south of Georges Bank, particularly around Hudson Canyon, have been seen at all times of the year but at low densities. The Virginia and North Carolina observations appear to represent the southern extent of the species range.

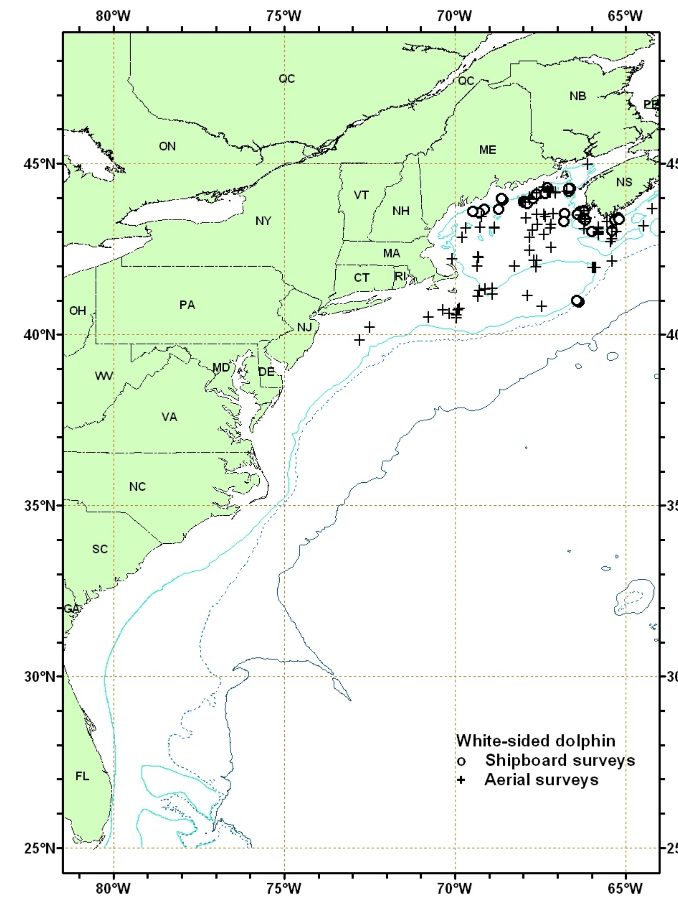

Figure 1. *Distribution of white-sided dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1998, 1999, and 2004. Isobaths are the 100m, 1000m, and 4000m depth contours.*

Prior to the 1970's, white-sided dolphins in U.S. waters were found primarily offshore on the continental slope, while white-beaked dolphins (*L. albirostris*) were found on the continental shelf. During the 1970's, there was an apparent switch in habitat use between these two species. This shift may have been a result of the decrease in herring and increase in sand lance in the continental shelf waters (Katona et al. 1993; Kenney et al. 1996).

POPULATION SIZE

The total number of white-sided dolphins along the eastern U.S. and Canadian Atlantic coast is unknown, although five estimates from select regions are available from: 1) spring, summer and autumn 1978-1982; 2) July-September 1991-1992; 3) June-July 1993; 4) July-September 1995; and 5) July-August 1999 (Figure 1; Table 1).

An abundance of 28,600 white-sided dolphins (CV=0.21) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982).

An abundance of 20,400 (CV=0.63) white-sided dolphins was estimated from two shipboard line transect surveys conducted during July to September 1991 and 1992 in the northern Gulf of Maine-lower Bay of Fundy region (Palka et al. 1997). This population size is a weighted-average of the 1991 and 1992 estimates, where each annual estimate was weighted by the inverse of its variance.

An abundance of 729 (CV=0.47) white-sided dolphins was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Anon. 1993).

An abundance of 27,200 (CV=0.43) white-sided dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Palka, Unpubl. Ms.). Total track line length was 32,600km. The ships covered waters between the 50 and 1000 fathom contours, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 51,640 (CV=0.38) white-sided dolphins was estimated from a 28 July to 31 August 1999 line-transect sighting survey conducted from a ship and an airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence (Table 1; Figure 1; D. Palka, Unpubl Ms.). Total track line length was 8,212km. Using methods similar to that used in the above 1995 survey, shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)* (Palka 2000). The 1999 estimate is larger than the 1995 estimate due to, at least in part, the fact that the 1999 survey covered the upper Bay of Fundy and the northern edge of Georges Bank for the first time and white-sided dolphins were seen in both areas.

Kingsley and Reeves (1998) estimated that there were 11,740 (CV=0.47) white-sided dolphins in the Gulf of St. Lawrence during 1995 and 560 (CV=0.89) white-sided dolphins in the northern Gulf of St. Lawrence during 1996 (Table 1). It is assumed these estimates apply to the Gulf of St. Lawrence stock. During the 1995 survey, 8,427km of track lines were flown in an area of 221,949km^2 during August and September. During the 1996 survey, 3,993km of track lines were flown in an area of 94,665km^2 during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line transect methods that model the left-truncated sighting curve. These estimates were uncorrected for visibility biases, such as *g(0)*.

The best available current abundance estimate for white-sided dolphins in the Gulf of Maine stock is 51,640 (CV=0.38) as estimated from the July to August 1999 line transect survey because this survey is recent and provided the most complete coverage of the known habitat.

Table 1. Summary of recent abundance estimates for western North Atlantic white-sided dolphins. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Gulf of Maine stock			
Jul-Aug 1999	Georges Bank to mouth of Gulf of St. Lawrence	51,640	0.38
Gulf of St. Lawrence stock			
July-Aug 1996	northern Gulf of St. Lawrence	560	0.89

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for the Gulf of Maine stock of white-sided dolphins is 51,640 (CV=0.38). The minimum population estimate for these white-sided dolphins is 37,904.

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: calving interval is 2-3 years; lactation period is 18 months; gestation period is 10-12 months and births occur from May to early August, mainly in June and July; length at birth is 110cm; length at sexual maturity is 230-240cm for males, and 201-222cm for females; age at sexual maturity is 8-9 years for males and 6-8 years for females; mean adult length is 250cm for males and 224cm for females (Evans 1987); and maximum reported age for males is 22 years and for females, 27 years (Sergeant et al. 1980).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow et al. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 37,904. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.48 because this stock is of unknown status and the CV of the mortality estimate is between 0.3 and 0.6. PBR for the Gulf of Maine stock of the western North Atlantic white-sided dolphin is 364.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Detailed fishery information is reported in Appendix III. Recently, within U.S. waters, white-sided dolphins have been observed caught in the Northeast sink gillnet, North Atlantic bottom trawl, and the Gulf of Maine/Georges Bank herring trawl TALFF fisheries (Table 2). Estimated average annual fishery-related mortality and serious injury to the Gulf of Maine stock of the western North Atlantic white-sided dolphin from these U.S. fisheries during 1999-2003 was 38 (CV=0.39) dolphins per year plus a pending estimate from the North Atlantic bottom trawl fishery.

Earlier Interactions

In the past, incidental takes of white-sided dolphins have been recorded in the Atlantic foreign mackerel and pelagic drift gillnet, mid-Atlantic coastal gillnet and southern New England/mid-Atlantic squid, mackerel, butterfish trawl fisheries. Fisheries information is reported in Appendix III.

NMFS observers in the Atlantic foreign mackerel fishery reported 44 takes of Atlantic white-sided dolphins incidental to fishing activities in the continental shelf and continental slope waters between March 1977 and December 1991 (Waring et al. 1990; NMFS unpublished data). Of these animals, 96% were taken in the Atlantic mackerel fishery. This total includes 9 documented takes by U.S. vessels involved in joint-venture fishing operations in which U.S. captains transfer their catches to foreign processing vessels.

During 1991 to 1998, two white-sided dolphins were observed taken in the Atlantic pelagic drift gillnet fishery, both in 1993. Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 4.4 (.71) in 1989, 6.8 (.71) in 1990, 0.9 (.71) in 1991, 0.8 (.71) in 1992, 2.7 (0.17) in 1993 and 0 in 1994 to 1998. There was no fishery during 1997.

The mid-Atlantic coastal gillnet fishery occurs year round from New York to North Carolina and has been observed since 1993. One white-sided dolphin was observed taken in this fishery during 1997. None were taken in other years. The estimated annual mortality (CV in parentheses) attributed to this fishery was 0 for 1993 to 1996, 45 (0.82) for 1997, 0 for 1998 to 2001, unknown in 2002 and 0 in 2003. During 2002, the overall observer coverage was lower than usual, 1%, where 65% of that coverage was off of Virginia and most of the rest of the area was not sampled at all. Thus, a bycatch estimate from these other areas cannot be confidently estimated.

Because of spatial and temporal differences in the harvesting of *Illex* and *Loligo* squid, and Atlantic mackerel, each of these sub-fisheries in the Southern New England/Mid-Atlantic squid, mackerel, butterfish trawl fisheries are described separately. No white-sided dolphin takes have been observed taken incidental to *Illex* and *Loligo* squid fishing operations since 1996. No incidental takes of white-sided dolphin were observed in the Atlantic mackerel JV fishery when it was observed in 1998. The U.S. domestic fishery for Atlantic mackerel occurs primarily in the Southern New England and mid-Atlantic waters between the months of January and May. One white-sided dolphin incidental take was observed in 1997 and none since than. The estimated mortality in 1997 was 161 (CV=1.58) animals.

U.S.

Northeast Sink Gillnet

This fishery occurs year round from in the Gulf of Maine, Georges Bank and in southern New England waters. Between 1990 and 2003 there were 48 white-sided dolphin mortalities observed in the Northeast sink gillnet fishery . Most were taken in waters south of Cape Ann during April to December. In recent years, the majority of the takes have been east and south of Cape Cod. During 2002, one of the takes was off Maine in the fall Mid-coast Closure Area in a pingered net. Estimated annual fishery-related mortalities (CV in parentheses) were 49 (0.46) in 1991, 154 (0.35) in 1992, 205 (0.31) in 1993, 240 (0.51) in 1994, 80 (1.16) in 1995, 114 (0.61) in 1996 (Bisack 1997a), 140 (0.61) in 1997, 34 (0.92) in 1998, 69 (0.70) in 1999, 26 (1.00) in 2000, 26 (1.00) in 2001, 30 (0.74) in 2002, and 31 (0.93) in 2003. Average annual estimated fishery-related mortality during 1999-2003 was 36 white-sided dolphins per year (0.39) (Table 2).

North Atlantic Bottom Trawl

The fishery is active in New England waters in all seasons. One moderately decomposed dolphin was brought up during a monkfish trawl in April 2001 east of Cape Cod. This moderately decomposed animal could not have been killed during this haul because the haul duration was only 4.6 hours. Three mortalities were documented between 1991 and 2001 in the North Atlantic bottom trawl fishery; 1 during 1992 and 2 during 1994. The 1 white-sided dolphin taken in 1992 was in a haul that was composed of 43% cod, 20% silver hake and 17% pollock. One of the 1994 takes was in a haul that was composed of 42% white hake, 19% pollock and 16% monkfish. The other 1994 take was in a haul that kept seven species of which none were dominant. One white-sided dolphin was observed taken in the Gulf Maine region during 2002 and 14 during 2003. The expanded bycatch estimate is pending. In 2002, there was one take reported through the Marine Mammal Authorization Program (MMAP) that was taken in a North Atlantic bottom trawl haul. The estimated fishery-related mortality in 1992 was 110 (CV=0.97), in 1994 it was 182 (CV=0.71), in 2002 and 2003 it was not yet been calculated, and it was 0 in other years (Bisack 1997b). The average annual estimate fishery-related mortality during 1999 to 2003 is pending.

Northeast Atlantic (Gulf of Maine/Georges Bank) Herring Fishery

A U.S. joint venture (JV) mid-water (pelagic) trawl fishery was conducted during 2001 on Georges Bank from August to December. No white-sided dolphins were incidentally captured. Two white-sided dolphins were incidentally captured in a single mid-water trawl during foreign fishing operations (TALFF) (Table 2). The total mortality attributed to the Atlantic herring mid-water trawl fishery in 2001 was 2 animals (Table 2).

Table 2. Summary of the incidental mortality of white-sided dolphins (*Lagenorhynchus acutus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast Sink Gillnet	99-03	1993=349 1998=301	Obs. Data Weighout Trip Logbook	.06, .06, .04,.02, .03	4[3],1[3] , 1[3], 1[3], 1[3]	69[3],26[3], 26[3] ,30[3], 31[3]	.70,1.00, 1.00, .74, .93	36 (0.39)
North Atlantic Bottom Trawl	99-03	TBD	Obs. Data Weighout	.003, .004, .004, .021, TBD	0, 0, 0, 1, 14	0, 0, 0, TBD[4], TBD[4]	0, 0, 0, TBD[4], TBD[4]	TBD[4]
GOM/GB Herring Trawl-TALFF	2001	2[5]	Obs. Data	1.00[5]	2	2	0	2 (0)
Total								38 (0.39)

1 Observer data (Obs. Data), used to measure bycatch rates, are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects landings data (Weighout) which is used as a measure of total effort. Mandatory Vessel Trip Report (VTR) (Trip Logbook) data are used to determine the spatial distribution of fishing effort in the sink gillnet fishery.

2 Observer coverage for the Northeast sink gillnet and both trawl fisheries are measured in trips and the mid-Atlantic coastal gillnet fishery is measured in tons of fish landed.

3 White-sided dolphins taken before 1997 in observed pinger trips were added directly to the estimated total bycatch for that year. After 1998, a weighted bycatch rate was applied to effort from both pingered and non-pingered hauls within the stratum where white-sided dolphins were observed taken. During the years 1997, 1999, 2001 and 2002, respectively, there were 2, 1, 1 and 1 observed white-sided dolphins taken on pingered trips. No takes were observed on pinger trips during 1995, 1996, 1998 and 2000.

4 TBD, to be determined. Estimating mortality attributed to the North Atlantic bottom trawl fishery is in progress.

5 Their were two foreign vessels that harvested Atlantic Herring in the U.S. fishery under a TALFF quota. During TALFF fishing operations all nets fished by the foreign vessel are observed.

CANADA

There is little information available which quantifies fishery interactions involving white-sided dolphins in Canadian waters. Two white-sided dolphins were reported caught in groundfish gillnet sets in the Bay of Fundy during 1985 to 1989, and 9 were reported taken in West Greenland between 1964 and 1966 in the now non-operational salmon drift nets (Gaskin 1992). Several (number not specified) were also taken during the 1960's in the now non-operational Newfoundland and Labrador groundfish gillnets. A few (number not specified) were taken in an experimental drift gillnet fishery for salmon off West Greenland which took place from 1965 to 1982 (Read 1994).

Hooker et al. (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on between 25-40% of large Canadian fishing vessels (greater than 100 feet long), and on approximately 5% of smaller Canadian fishing vessels. Bycaught marine mammals were noted as weight in kilos rather than by the numbers of animals caught. Thus the number of individuals was estimated by dividing the total weight per species per trip by the maximum recorded weight of each species. During 1991 through 1996, an estimated 6 white-sided dolphins were observed taken. One animal was from a longline trip south of the Grand Banks (43° 10'N 53° 08'W) in November 1996 and the other 5 were taken in the bottom trawl fishery off Nova Scotia in the Atlantic Ocean; 1 in July 1991, 1 in April 1992, 1 in May 1992, 1 in April 1993, 1 in June 1993 and 0 in 1994 to 1996.

Herring Weirs

During the last several years, one white-sided dolphin was released alive and unharmed from a herring weir in the Bay of Fundy (A. Westgate, pers. comm.). Due to the formation of a cooperative program between Canadian fishermen and biologists, it is expected that most dolphins and whales will be able to be released alive. Fishery information is available in Appendix III.

Other Mortality

U.S.

Mass strandings involving up to a hundred or more animals at one time are common for this species. From

1968 to 1995, 349 Atlantic white-sided dolphins were known to have stranded on the New England coast (Hain and Waring 1994; Smithsonian stranding records 1996). The causes of these strandings are not known. Because such strandings have been known since antiquity, it could be presumed that recent strandings are a normal condition (Gaskin 1992). It is unknown whether human causes, such as fishery interactions and pollution, have increased the number of strandings. Stranding data probably underestimate the extent of fishery-related mortality and serious injury because all of the marine mammals which die or are seriously injured may not wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

White-sided dolphin stranding records from 1997 to 2003 that are in the NMFS/NE Regional Office strandings and entanglement database have been reviewed, updated, and reported in Table 3. Cause of death was investigated and it was determined that the documented human interaction were the following: 1 animal possibly killed by a boat collision off Maine during 2001; 2 animals with indications of fishery interactions found in March 2002 in Massachusetts; 1 animal with indications of fishery interactions found in May 2002 in Virginia; and of the 66 animals found stranded during 2003, 57 were reported to have signs of fishery interactions. (Table 3).

Mass strandings in Massachusetts occur frequently (Table 3). There were 80 animals in a mass stranding near Wellfleet, Massachusetts, during the week of 29 January to 3 February 1998. Of these, 2 were released alive. Of the 4 found in Massachusetts during the November 1998 mass stranding, 1 was released alive. Fifty-three animals stranded in Wellfleet, Massachusetts during 19-24 March 1999. During 1999, of the 70 strandings, 38 were found alive, and 3 of these animals were released alive. During 2000, 5 were found alive (3 in April and 2 in August), and the 2 in August were released alive. During 2002, there were mass strandings in March and August, of which a few were released alive. During 2003 in Massachusetts 36 white-sided dolphins were involved in mass strandings in January, April and November, of which all had signs of fishery interactions and 25 were found alive.

CANADA

Small numbers of white-sided dolphins have been taken off southwestern Greenland and they have been taken deliberately by shooting elsewhere in Canada (Reeves et al. 1999). Whales and dolphins stranded during 1991 to 1996 on the coast of Nova Scotia were documented by the Nova Scotia Stranding Network (Hooker et al. 1997). Strandings on the beaches of Sable Island during 1970 to 1998 were documented by researchers with Dept. of Fisheries and Oceans (DFO), Canada (Lucas and Hooker 2000). Sable Island is approximately 170km southeast of mainland Nova Scotia. White-sided dolphins stranded at nearly all times of the year on the mainland and on Sable Island. On the mainland of Nova Scotia, a total of 34 stranded white-sided dolphins was recorded between 1991 and 1996: 2 in 1991 (August and October), 26 in July 1992, 1 in Nov 1993, 2 in 1994 (February and November), 2 in 1995 (April and August) and 2 in 1996 (October and December). During July 1992, 26 white-sided dolphins stranded on the Atlantic side of Cape Breton. Of these, 11 were released alive and the rest were found dead. Among the rest of the Nova Scotia strandings, 1 was found in Minas Basin, 2 near Yarmouth and the rest near Halifax. On Sable Island, 10 stranded white-sided dolphins were documented between 1991 and 1998; all were males, 7 were young males (< 200cm), 1 in January 1993, 5 in March 1993, 1 in August 1995, 1 in December 1996, 1 in April 1997 and 1 in February 1998.

Whales and dolphins stranded between 1997 and 2004 on the coast of Nova Scotia as recorded by the Marine Animal Response Society (MARS) and the Nova Scotia Stranding Network are as follows (Table 3): 0 white-sided dolphins stranded in 1997 to 2000, 3 in September 2001 (released alive), 5 in November 2002 (4 were released alive), 0 in 2003, and 20-25 in 2005 (15-20 in October (some (unspecified) were released alive) and 4 in November were released alive).

Table 3. Summary of number of stranded white-sided dolphins during January 1, 1999 to December 31, 2003, by year and area within U.S. and Canada.

Area						Total
	1999	2000	2001	2002	2003	
Maine[2]	1		2	4	2	9
New Hampshire						0
Massachusetts[1,2]	65	24	16	53	59	217
Rhode Island				2		2
Connecticut					1	1
New York				1	2	3
New Jersey	3			1	1	5
Delaware						0
Maryland						0
Virginia[2]	1			1		2
North Carolina					1	1
TOTAL US	70	24	18	62	66	240
Nova Scotia	0	0	0	1	1	2
GRAND TOTAL	70	24	18	63	67	242

1 Records of mass strandings in Massachusetts are: March 1999 - 53 animals; April 2000 - 5 animals; August 2000 - 11 animals; April 2001 - 6 animals; March 2002 - 31 animals, of which 7 were released alive; August 2002 - 3 animals, of which 1 was released alive; January 2003 - 4 animals; April 2003 - 28 animals; November 2003 - 4 animals.

2 Strandings that appear to involve a human interaction are:1 animal from Maine in 2001 that was a possible boat collision;1 animal from Virginia in May 2002 had signs of fishery interaction; 2 animals from Massachusetts in March 2002 had signs of fishery interactions; 57 out of the 66 US strandings in 2003 have signs of fishery interactions (1in Maine, 54 in Massachusetts, 1 in Connecticut, 1 in New Jersey).

STATUS OF STOCK

The status of white-sided dolphins, relative to OSP, in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population trends for this species. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a non-strategic stock because estimated average annual fishery-related mortality and serious injury does not exceed PBR.

REFERENCES

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine Mammal Survey. 5 pp. [Available from: NMFS, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543.]

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S.Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K. D. 1997a. Harbor porpoise bycatch estimates in the New England multispecies sink gillnet fishery: 1994 and 1995. *Rep. int Whal. Comm* 47: 705-14.

Bisack, K. D. 1997b. Marine mammal bycatch estimates and their sampling distributions in the U.S. New England sink gillnet, pair trawl, Atlantic pelagic drift gillnet and North Atlantic bottom trawl fisheries - 1994 to 1996. NOAA, NMFS, NEFSC. Woods Hole, MA. Working paper SC/49/SM35 submitted to the IWC Scientific Committee meeting in Bournemouth, UK, Aug/Sept 1997.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Evans, P. G. H. 1987. *The natural history of whales and dolphins.* Facts on File Publications, New York, 343 pp.

Gaskin, D. E. 1992. Status of Atlantic white-sided dolphin, *Lagenorhynchus acutus*, in Canada. *Can. Fld. Nat.* 106: 64-72.

Hain, J. H. W. and G. T. Waring. 1994. Status of and human effects upon marine mammals. Pages. 9-20 *In:* R. W. Langton , J. B. Pearce, and J.A. Gibson (eds). *Selected living resources, habitat conditions, and human perturbations of the Gulf of Maine: Environmental and ecological considerations for fishery managements.* NOAA Tech. Mem. NMFS-NE-106. [Available from: NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543].

Hooker, S. K., R. W. Baird and M. A. Showell. 1997. Cetacean strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Meeting document SC/49/O5 submitted to the 1997 International Whaling Commission meeting in Bournemouth, UK.

Katona, S. K., V. Rough and D. T. Richardson. 1993. *A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland.* Smithsonian Institution Press. Washington, DC. 316 pp.

Kenney, R. D., P. M. Payne, D. W. Heinemann and H. E. Winn. 1996. Shifts in Northeast shelf cetacean distributions relative to trends in Gulf of Maine/Georges Bank finfish abundance. Pp. 169-196 *in:* K. Sherman, N.A. Jaworski and T. Smada (eds.). *The northeast shelf ecosystem: assessment, sustainability, and management.* Blackwell Science, Cambridge, MA 02142, USA.

Kingsley, M. C. S. and R. R. Reeves. 1998. Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. *Can. J. Zool.* 76:1529-1550.

Lucas, Z. N. and S. K. Hooker. 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. *Can. Fld. Nat.* 114(1): 46-61.

Northridge, S., M. Tasker, A. Webb, K. Camphuysen and M. Leopold. 1997. White-beaked *Lagenorhynchus albirostris* and Atlantic white-sided dolphin *L. acutus* distributions in northwest European and U.S. North Atlantic waters. *Rep. int. Whal. Commn* 47:797-805.

Palka, D. 2000. Abundance of the Gulf of Maine/Bay of Fundy harbor porpoise based on shipboard and aerial surveys during 1999. NOAA/NMFS/NEFSC Ref. Doc. 00-07. 29 pp. [Available from: NMFS, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543.]

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC Ref. Doc. 96-04. 37 pp. [Available from: NMFS, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543.]

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. pp. 27-50 *In*: A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int Whal. Commn* Special Issue 16.

Palka, D., A. Read and C. Potter. 1997. Summary of knowledge of white-sided dolphins (*Lagenorhynchus acutus*) from the U.S. and Canadian North Atlantic waters. *Rep. int Whal. Commn* 47: 729-34.

Payne, M. and D. W. Heinemann. 1990. A distributional assessment of cetaceans in the shelf and shelf edge waters of the northeastern United States based on aerial and shipboard surveys, 1978-1988. Report to NMFS. 108p. [Available from National Marine Fisheries Science Center, 166 Water St., Woods Hole, MA 02543.]

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int Whal. Commn* Special Issue 15: 133-147.

Reeves, R. R., C. Smeenk, R. L. Brownell, Jr. and C. C. Kinze. 1999. Atlantic white-sided dolphin *Lagenorhynchus acutus* (Gray, 1828). Pp. 31-56 *In* S. H. Ridgway and Sir R. Harrison (eds.) *Handbook of Marine Mammals. Volume 6: The Second Book of Dolphins and the Porpoises.* Academic Press, Boston.

Sergeant, D. E., D. J. St. Aubin and J. R. Geraci. 1980. Life history and northwest Atlantic status of the Atlantic white-sided dolphin, *Lagenorhynchus acutus*. *Cetology* 37: 1-12.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S.* 88(2): 347-360.

November 2004

COMMON DOLPHIN (*Delphinus delphis*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The common dolphin may be one of the most widely distributed species of cetaceans, as it is found world-wide in temperate, tropical, and subtropical seas. In the North Atlantic, common dolphins appear to be present along the coast over the continental shelf along the 200-2000m isobaths or over prominent underwater topography from 50° N to 40°S latitude (Evans 1994). The species is less common south of Cape Hatteras, although schools have been reported as far south as eastern Florida (Gaskin 1992). At least some of the reported sightings of common dolphins in the Gulf of Mexico may have been *Stenella clymene*, which has a color pattern similar to that of common dolphins (Evans 1994). NMFS is currently funding genetic and skull morphometric studies, which will provide information on common dolphin stock structure in the western North Atlantic. Preliminary work had documented a high variance in skull morphometric measurements, suggesting the existence of more than a single stock . Common dolphins are distributed along the continental slope (100 to 2,000 meters), and are associated with Gulf Stream features in waters off the northeastern U.S. coast (CETAP 1982; Selzer and Payne 1988; Waring *et al.* 1992). They are widespread from Cape Hatteras northeast to Georges Bank (35° to 42° North latitude) in outer continental shelf waters from mid-January to May (Hain *et al.* 1981; CETAP 1982; Payne *et al.* 1984). Common dolphins move northward onto Georges Bank and the Scotian Shelf from mid-summer to autumn (Palka *et al.* Unpub. Ms.; Figure 1). Selzer and Payne (1988) reported very large aggregations (greater than 3,000 animals) on Georges Bank in autumn. Common dolphins are occasionally found in the Gulf of Maine, where temperature and salinity regimes are lower than on the continental slope of the Georges Bank/mid-Atlantic region (Selzer and Payne 1988). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs during summer and autumn when water temperatures exceed 11°C (Sergeant *et al.* 1970; Gowans and Whitehead 1995).

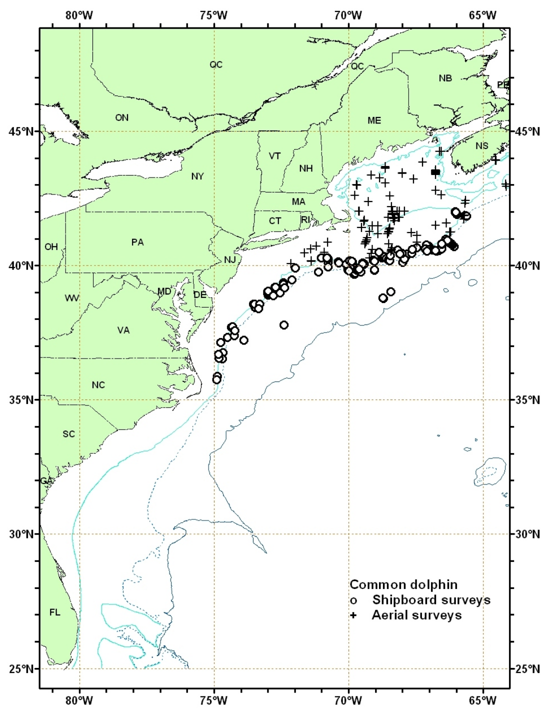

Figure 1. Distribution of common dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer 1998, 1999, and 2004. Isobaths are 100 m, 1,000 m and 4,000 m.

POPULATION SIZE

Total numbers of common dolphins off the USA or Canadian Atlantic coast are unknown, although several estimates from selected regions of the habitat do exist for selected time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 29,610 common dolphins (CV=0.39) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 22,215 (CV=0.40) common dolphins was estimated from a June and July 1991 shipboard line-transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 1,645 (CV=0.47) common dolphins was estimated from a June and July 1993 shipboard line-transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of

Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for *g(0)* or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 6,741 (CV=0.69) common dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* Unpub. Ms.). Total track line length was 32,600km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour , the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom isobath. Data collection and analysis methods used were described in Palka (1996).

An abundance of 30,768 (CV=0.32) common dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* Unpub. Ms.). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)*.

No common dolphins were encountered during the SEFSC component of the joint surveys. That shipboard line transect sighting survey was conducted between 8 July and 17 August 1998 and surveyed 4,163 km of track line in waters south of Maryland (38°N) (Mullin and Fulling 2003)).

Although the 1991, 1993, 1995, and 1998 surveys did not sample the same areas or encompass the entire common dolphin habitat (e.g., little effort in Scotian shelf edge waters), they did focus on segments of known or suspected high-use habitats off the northeastern USA coast. The 1993, 1995 and 1998 data suggest that, seasonally, at least several thousand common dolphins are occupying continental shelf edge waters, with perhaps highest abundance in the Georges Bank region.

An abundance of 85,809 (CV= 0.294) common dolphins was estimated from a line-transect sighting survey conducted during June 12 to August 4, 2004 by a ship and plane that surveyed 10,761 km of track line in waters north of North Carolina (about 36.5° N) (Figure 1; Palka Unpub. Ms.). Shipboard data were collected using the two independent team line-transect method and analyzed using the modified direct duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and *g(0)*, the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line transect method (Hiby 1999) and analyzed accounting for *g(0)* and biases due to school size and other potential covariates (Figure 1; Palka Unpub. Ms.).

A ship survey of the U.S. Atlantic outer continental shelf and continental slope (water depths ≥ 50m) between Florida and Maryland (27.5 and 38º N latitude) was conducted during June-August, 2004. The survey employed two independent visual teams searching with 50x bigeye binocluars. Survey effort was stratified to include increased effort along the continental shelf break and Gulf stream front in the mid-Atlantic. The survey included 5,659 km of trackline, and there was a total of 473 cetacean sightings. Sightings were most frequent in waters north of Cape Hatteras, North Carolina along the shelf break. Data were analyzed to correct for visibility bias (*g(0)*) and group-size bias employing line-transect distance analysis and the direct duplicate estimator (Palka, 1995; Buckland *et al.*, 2001). The resulting abundance estimate for common dolphins between Florida and Maryland was 30,196 (CV =0.537).

The best 2004 abundance estimate for common dolphins is the sum of the estimates from the two 2004 U.S. Atlantic surveys, 116,005 (CV = 0.258), where the estimate from the northern U.S. Atlantic is 85,809 (CV =0.294), and from the southern U.S. Atlantic is 30,196 (CV =0.537). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Table 1. Summary of abundance estimates for western North Atlantic common dolphin. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	30,768	0.320.27
Jun-Aug 2004	Maryland to Bay of Fundy	85,809	0.29
Jun-Aug 2004	Florida to Maryland	30,196	0.54
Jun-Aug 2004	Bay of Fundy to Florida	116,005	0.26

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for common dolphins is 116,005 (CV =0.26). The minimum population estimate for the western North Atlantic common dolphin is 93,663.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 93,663. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.48 because the CV of the average mortality estimate is between 0.3 and 0.6 (Wade and Angliss 1997), and because this stock is of unknown status. PBR for the western North Atlantic common dolphin is 899.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery information

Detailed fishery information is reported in Appendix III.

Total annual estimated average fishery-related mortality or serious injury to this stock during 1999-2003 was 119 common dolphins (CV =0.43; Table 2).

Earlier Interactions

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the U.S. With implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA), an observer program was established which has recorded fishery data and information of incidental bycatch of marine mammals. During the period 1977-1986, observers recorded 123 mortalities in foreign *Loligo* squid-fishing activities (Waring *et al.* 1990). In 1985 and 1986, Italian vessels took 56 and 54 animals, respectively, which accounts for 89% (n=110) of the total takes in foreign *Loligo* squid-fishing operations. No mortalities were reported in foreign *Illex* squid fishing operations. Because of spatial/temporal fishing restrictions, most of the bycatch occurred along the continental shelf edge (100m) isobath during winter (December to February).

From 1977 to 1991, observers recorded 110 mortalities in foreign mackerel-fishing operations (Waring *et al.* 1990; NMFS unpublished data). This total includes one documented take by a U.S. vessel involved in joint-venture fishing operations in which U.S. captains transfer their catches to foreign processing vessels. The bycatch occurred during winter/spring (December to May).

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic pair trawl, pelagic longline , mid-Atlantic coastal gillnet, North Atlantic bottom trawl, Northeast sink gillnet, and Atlantic squid, mackerel, butterfish trawl fisheries.

Pelagic Longline

Since 1992, this fishery has been monitored with about 5% observer coverage, in terms of trips observed, within every statistical reporting area within the U.S. Atlantic EEZ and beyond. Off the U.S. Atlantic coast, the fishery has been observed from January to March off Cape Hatteras, in May and June in the entire mid-Atlantic, and in July through December in the mid-Atlantic Bight and off Nova Scotia. The 1994-1998 estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 1992-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999). Further, Yeung (1999b) revised the 1992-1997 fishery mortality estimates in Johnson *et al.* (1999) to include seriously injured animals. The 1998 bycatch estimates were from Yeung (1999a). Most of the estimated marine mammal bycatch was from U.S. Atlantic EEZ waters between South Carolina and Cape Cod (Johnson *et al.* 1999). Between 1990 and 2000, sixteen common dolphins were hooked and released alive (Yeung *et al.* 2000; Yeung 2001).

Northeast Multispecies Sink Gillnet

The fishery has been observed in the Gulf of Maine and in Southern New England. In 1996, the first observed mortality of common dolphins in this fishery was recorded. The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 0 in 1995, 63 in 1996 (1.39), 0 in 1997, 0 in 1998, 146 in 1999 (0.97) and 0 in 2000-2003 ; estimated annual mortality in 1999-2003 was 29 common dolphins (0.97) (Table 2).

Mid-Atlantic Coastal Gillnet

This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records which are held by both state and federal agencies have not been centralized and standardized. No common dolphins were taken in observed trips during 1993 and 1994. Two common dolphins were observed taken in 1995, 1996 and 1997, and no takes were observed from 1998-2002 (Table 2). Observed effort was concentrated off New Jersey and scattered between Delaware and North Carolina from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 7.4 in 1995 (0.69), 43 in 1996 (0.79), 16 in 1997 (0.53), and 0 in 1999-2003. Average annual estimated fishery-related mortality attributable to this fishery during 1999-2003 was zero common dolphins.

Southern New England/Mid-Atlantic Squid, Mackerel, Butterfish Trawl Fisheries

Historically, the mid-Atlantic mackerel and squid trawl fisheries were combined into the Atlantic mid-water trawl fishery in the revised proposed list of fisheries in 1995. The mackerel trawl fishery was classified as a Category II fishery since 1990 and the squid fishery was originally classified as a Category II fishery in 1990, but was reclassified as a Category III fishery in 1992. The combined fishery was then reclassified as a Category II fishery in 1995.

***Illex* Squid**

The U.S. domestic fishery, ranging from southern New England to Cape Hatteras North Carolina, reflects patterns in the seasonal distribution of *Illex* squid (*Illex illecebrosus*). *Illex* are harvested offshore mainly by small mesh otter trawlers when they are distributed in continental shelf and slope waters during the summer months (June-September)(Clark ed. 1998). No incidental takes of common dolphins have been observed in the *Illex* fishery.

***Loligo* Squid**

The U.S. domestic fishery for *Loligo* squid (*Loligo pealeii*) occurs mainly in southern New England and mid-Atlantic waters. Fishery patterns reflect *Loligo* seasonal distribution where most effort is directed offshore near the edge of the continental shelf during the fall and winter months (October-March), and inshore during the spring and summer months (April-September) (Clark ed. 1998). This fishery is dominated by small-mesh otter trawlers, but substantial landings also are taken by inshore pound nets and fish traps during the spring and summer months (Clark ed. 1998). All incidental takes attributed to this fishery were observed during the first quarter of the year (Jan-Mar), exclusively in the offshore fishery. The estimated fishery-related mortality of common dolphins attributable to the fall/winter offshore fishery was 0 between 1997-1998, 49 in 1999 (CV=0.97), 273 in 2000 (CV=0.57), 126 in 2001 (CV=1.09) and 0 in 2002-2003. The average annual mortality between 1999-2003 was 90 common dolphins (CV=0.47) (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

Atlantic Mackerel

The U.S. domestic fishery for Atlantic mackerel (*Scomber scombrus*) occurs primarily in the southern New England and mid-Atlantic waters between the months of January and May (Clark ed. 1998). This fishery is dominated by mid-water (pelagic) trawls. Observer coverage of this fishery was 0.79%, 0.00%, 1.13%, 4.9% and The estimated fishery-related mortality attributed to this fishery was 161 (CV=0.49) animals in 1997 and 0 between 1999-2003. The average annual mortality between 1999-2003 was 0 (zero) (Table 2).

A U.S. joint venture (JV) fishery was conducted in the mid-Atlantic region from February-May 1998. NMFS, maintained 100% observer coverage on the foreign JV vessels where 152 transfers from the U.S. vessels were observed. Seventeen incidental takes of common dolphin were observed in the 1998 JV mackerel fishery. This fishery did not operate in 1999-2003. The former distant water fleet fishery has been non-existent since 1977. There is also a mackerel trawl fishery in the Gulf of Maine that generally occurs during the summer and fall months (May-December).

Southern New England/Mid-Atlantic Bottom Trawl Fisheries

This fishery occurs year round ranging from Cape Cod Massachusetts to Cape Hatteras North Carolina. It represents a variety of individual sub-fisheries that include but are not limited to; monkfish, summer flounder (fluke), winter flounder, silver hake (whiting), spiny and smooth dogfish, scup, and black sea bass. There was one observed take in this fishery reported in 1997. The estimated fishery-related mortality for common dolphins attributable to this fishery was 93 (CV=1.06) animals in 1997 and 0 between 1999-2003. The average annual mortality between 1999-2003 was 0 (zero) common dolphins (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

Table 2. Summary of the incidental mortality and serious injury of common dolphins (*Delphinus delphis*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels[3]	Data Type [1]	Observer Coverage[2]	Observed Serious Injury	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Estimated Combined Mortality	Estimated CVs	Mean Annual Mortality
Northeast Multispecies Sink Gillnet	99-03	349	Obs. Data Dealer, Logbooks	.06, .06, .04, .02, .03	0, 0, 0, 0, 0	2, 0, 0, 0, 0	0, 0, 0, 0, 0	146, 0, 0, 0, 0	146, 0, 0, 0, 0	.97, 0, 0, 0, 0	29 (.97)
Mid-Atlantic Coastal Gillnet	99-03	NA	Obs. Data Dealer	.05, .02, .02, .02, .01, .01	0, 0, 0, 0, 0	0, 0, 0, unk[5], 0	0, 0, 0, 0, 0	0, 0, 0, unk[5], 0	0, 0, 0, unk[5], 0	0, 0, 0, 0, unk[5], 0	0 (0)[5]
North Atlantic Bottom Trawl	99-03	TBD	Obs. Data Weighout	.001, .003, .004, .004, .021, tbd	0, 0, 0, 0, 0	0, 0, 0, 1, 0	0, 0, 0, 0, 0	0, 0, 0, TBD[6], tbd[6]	0, 0, 0, TBD[6], tbd[6]	0, 0, 0, TBD[6], tbd[6]	TBD[6]
SNE/mid-Atlantic Loligo Squid Trawl (offshore)	99-03	384 [4]	Obs. Data Dealer	.009, .011, .012, .005, tbd	0, 0, 0, 0, 0	1, 6, 2, 0, 0	0, 0, 0, 0, 0	49, 273, 126, 0, 0	49, 273, 126, 0, 0	.78, .57, 1.09, 0, 0	90 (.47)
SNE/ mid-Atlantic Bottom Trawl	99-03	NA	Obs. Data Dealer	.003, .003, .004, .005, tbd	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	(0) 0
SNE/Mid-Atlantic Mackerel Trawl-domestic	99-03	2,242 [4]	Obs. Data Dealer	.01, .04, .03, .006 , tbd	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 00	0 (0.0) 0 (0)
SNE/Mid-Atlantic Mackerel Trawl-JV[7]	99-03	1999-2001=0 2002=2 2003=0	Obs. Data	NA,NA, NA, 1.00, NA	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0, 0, 0, 0	0 (0)
TOTAL											119 (.43)

[1] Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects dealer reported landings data. Total landings are used as a measure of total effort for the coastal gillnet, Northeast sink gillnet and the SNE/mid-Atlantic and squid, mackerel, butterfish trawl fisheries.

[2] The observer coverage for the Northeast multispecies sink gillnet fishery are measured in trips. Observer coverage for the mid-Atlantic coastal sink gillnet fishery is measured in tons of fish landed. Observer coverage of the SNE/mid-Atlantic and squid, mackerel, butterfish trawl fisheries are measured in trips.

[3] These are numbers of potential fishing vessels based on permit holders in the 2002 fishery. Many of these vessels participate in the other fisheries and therefore the reported number of vessels are not additive across the squid, mackerel and butterfish fisheries. (67FR 65937).

[4] The incidental take was observed on a trip than landed scup as the primary species.

[5] Sixty-five percent of sampling by the NEFSC fisheries observer program was concentrated in one area and not distributed proportionally across the fishery. Therefore, observed mortality is considered unknown in 2002. The previous five year average (97-01) estimated mortality was applied.

[6] Mortality estimation attributed to the North Atlantic bottom trawl fishery is in progess.

[7] NA=No joint venture fishing effort for Atlantic mackerel.

[8] During joint venture fishing operations, nets that are transferred from the domestic vessel to the foreign vessels for processing are observed on board the foreign vessel. There may be nets fished by domestic vessels that do not get transferred to a foreign vessel for processing and therefore would not be observed. During TALFF fishing operations all nets fished by the foreign vessel are observed.

CANADA

Between January 1993 and December 1994, 36 Spanish deep water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211 sets), were observed in NAFO Fishing Area 3 (off the Grand Banks) (Lens 1997). A total of 47 incidental catches were recorded, which included 1 common dolphin. The incidental mortality rate for common dolphins was 0.007/set.

Other Mortality

From 1998 to 2002, 180 common dolphins were reported stranded between Maine and Florida (Table 3). The total includes mass stranded common dolphins in Massachusetts during 1997 (10 animals) and 2002 (9 animals); 1998 (9 animals and 5 animals); and 1999 (3 animals), and in North Carolina in 2001 (7animals). Three common dolphins which had stranded alive in Massachusetts in 2000 were released. In 1999, 1 stranding mortality in New Jersey was designated as a human interaction (fishing gear). In 2001, the cause of death of one stranding mortality in Virginia and another animal in North Carolina were designated as human interactions/fishing interactions. Similarly in 2002, the case of death for one stranding in New York and another animal in Virginia were designated as human interaction/fishery interaction.

Four common dolphin strandings (6 individuals) were reported on Sable Island, Nova Scotia from 1970 to 1998, with all having occurred since 1996 (Lucas and Hooker 1997; Lucas and Hooker 2000).

Table 3. Common dolphin (*Delphinus delphis*) reported strandings along the U.S. Atlantic coast, 1999-2003.

STATE	**1999**	**2000**	**2001**	**2002**	**2003**	**TOTALS**
Maine	0	0	1	0	0	1
Massachusetts[1]	11	10	8	34	21	84
Rhode Island	5	5	0	1	2	13
Connecticut	0	1	0	0	0	1
New York	6	4	6	5	11	32
New Jersey	3[3]	5	5	1	6	20
Delaware	1	1	1	1	1	5
Maryland	0	3	2	0	0	5
Virginia	2	1	4[3]	3	4	14
North Carolina[4]	0	6	14[3]	0	62	26
Georgia	0	1	0	0	0	1
TOTALS	28	37	41	45	51	202

1 Massachusetts mass strandings (1997 - 10 animals, 1998 - 9 and 5 animals, 1999 - 3 animals; 2002 - 9 animals)

2 Boat collision (14 Feb 1997 - Rhode Island)

3 Fishery Interactions (FI)/Human Interactions (HI) - North Carolina reported 1 HI, fishing gear, April 2001; Virginia - 1 FI March 2001; New Jersey - 1 FI reported with net marks January 1999)

4 North Carolina mass stranding (2001 - 7 animals)

5 2002 FI, one in NY, one in Va.

STATUS OF STOCK

The status of common dolphins, relative to OSP, in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because the 1999-2003 average annual fishery-related mortality and serious injury does not exceed PBR. In the last five editions of this stock assessment report, it has been designated as non-strategic in 2002 and 2003.

REFERENCES

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. 5 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Andersen, K. P. Burnham and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 446 pp.

Buckland, S. T., D.R. Andersen, K.P Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling estimating abundance of biological populations. *Oxford University Press*, New York, 432 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Cramer, J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352. 19 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL 33149.

Evans, W. E. 1994. Common dolphin, white-bellied porpoise. Pp 191-224. *In:* S. H. Ridgway and R. Harrison (eds.). *Handbook of marine mammals*, Volume 5: The first book of dolphins. *(Academic Press*,) San Diego, CA.

Gaskin, D. E. 1992. Status of common dolphin, *Delphinus delphis*, in Canada. *Can. Field-Nat*. 106: 55-63.

Gerrior, P., A. S. Williams and D. J. Christensen. 1994. Observations of the 1992 U.S. pelagic pair trawl fishery in the northwest Atlantic. *Mar. Fish. Rev*. 56(3): 24-27.

Goudey, C. A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic. MITSWG 95-6, Massachusetts Institute of Technology, Sea Grant, Cambridge, MA. 10 pp.

Goudey, C. A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic. MITSG 96-17, Massachusetts Institute of Technology, Sea Grant, Cambridge, MA. 13 pp.

Gowans, S. and H. Whitehead. 1995. Distribution and habitat partitioning by small odontocetes in the Gully, a submarine canyon on the Scotian Shelf. *Can. J. Zool*. 73: 1599-1608.

Hain, J. H. W., R. K. Edel, H. E. Hays, S. K. Katona and J. D. Roanowicz. 1981. General distribution of cetaceans in the continental shelf waters of the northeastern U.S. Pages II1-II277. *In:* CETAP (Cetacean and Turtle Assessment program), A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf, Annual Report for 1979. Contract No. AA551-CT8-48, U.S. Dept. of Interior, Bureau of Land Management, Washington, DC.

Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 *in*: Garner *et al.* (eds). Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.

Johnson, D. R., C. A. Brown and C. Yeung. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. NOAA Technical Memorandum NMFS- SEFSC-418. 70 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL 33149.

Laake, J. L., S. T. Buckland, D. R. Anderson and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, CO. 72 pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES CM* 1997/Q:8. 10 pp.

Lucas, Z. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Paper SC/49/06 presented to the IWC Scientific Committee, September 1997. 10 pp.

Lucas, Z. N. and S. K. Hooker. 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. *Can. Field-Nat.*:114 (45-61).

Mullin, K. D. And G.L. Fulling. 2003. . Abundance of cetaceans in the southern U.S. North Atlantic Ocean during summer 1998. *Fish. Bull., U.S.* 101:603-613.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report, Contract No. 40ENNF500160, to the NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. *Rep. int Whal. Commn*. Special Issue 16:27-50.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37 pp. Available from: NMFS, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543.

Palka, D. and Hammond, P.S. 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci. 58: 777-787.

Palka, D., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998.

Payne, P. M., L. A. Selzer and A. R. Knowlton. 1984. Distribution and density of cetaceans, marine turtles, and seabirds in the shelf waters of the northeastern United States, June 1980-December 1983, based on shipboard observations. NOAA/NMFS Contract No. NA-81-FA-C-00023. 245 pp.

Scott, G.P. and C.A. Brown. 1997. Estimates of marine mammal and turtle catch by the U.S. Atlantic pelagic longline fleet in 1994-1995. Miami Laboratory Contribution MIA-96/97-28.

Selzer, L. A. and P. M. Payne. 1988. The distribution of white-sided (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. *Mar. Mammal. Sci*. 4(2): 141-153.

Sergeant, D. E., A. W. Mansfield and B. Beck. 1970. Inshore records of cetacea for eastern Canada, 1949-68. *J. Fish. Res. Bd. Can.* 27: 1903-1915.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21 pp. Available from: NMFS, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543,

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S.* 88(2): 347-360.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES* Marine Mammals Comm. CM 1992/N: 12, 29 pp.

Waring, G. T., D. L. Palka, P. J. Clapham, S. Swartz, M. C. Rossman, T. V. N. Cole, L. J. Hansen, K. D. Bisack, K. D. Mullin, R. S. Wells, D. K. Odell, and N. B. Barros. 1999. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments — 1999. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NE-153, 196 pp.

Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Tech. Memo. NMFS-SEFSC-430, 26 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL 33149.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Tech. Memo. NMFS-SEFSC-429, 23 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL 33149.

Yeung, C., S. Epperly, and C. A. Brown. 2000. Preliminary revised estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet, 1992-1999. NMFS, Miami Lab. PRD Contribution Number 99/00-13. 58 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL 33149.

Yeung, C. 2001. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1999-2000. NOAA Tech. Memo. NMFS-SEFSC-467, 43 pp. Available from: NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL 33149.

November 2004

CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of Cuvier's beaked whales is poorly known, and is based mainly on stranding records (Leatherwood *et al.* 1976). Strandings have been reported from Nova Scotia along the eastern U.S. coast south to Florida, around the Gulf of Mexico, and within the Caribbean (Leatherwood *et al.* 1976; CETAP 1982; Heyning 1989; Houston 1990; Mignucci-Giannoni *et al.* 1999). Stock structure in the North Atlantic is unknown.

Cuvier's beaked whale sightings have occurred principally along the continental shelf edge in the mid-Atlantic region off the northeast U.S. coast (CETAP 1982; Waring *et al.* 1992; Waring *et al.* 2001; Palka *et al.* Unpub. Ms.). Most sightings were in late spring or summer.

POPULATION SIZE

The total number of Cuvier's beaked whales off the eastern U.S. and Canadian Atlantic coast is unknown. However, several estimates of the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 120 undifferentiated beaked whales (CV=0.71) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 442 (CV=0.51) undifferentiated beaked whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Anon. 1990; Waring *et al.* 1992). An abundance of 262 (CV=0.99)undifferentiated beaked whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobathsfrom Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). An abundance of 370 (CV=0.65) and 612 (CV=0.73) undifferentiated beaked whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

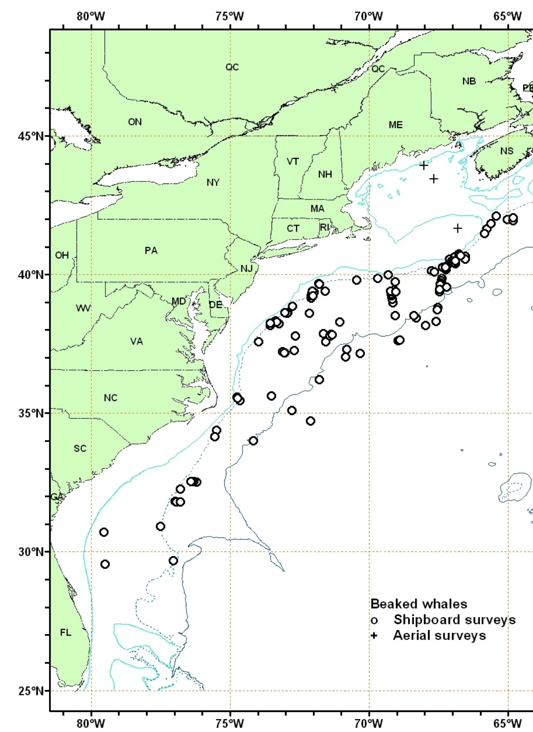

Figure 1. Distribution of beaked whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer 1998, 1999, and 2004. Isobaths are 100 m, 1,000 m, and 4,000 m.

An abundance of 330 (CV=0.66) undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for *g(0)* or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 99 (CV=0.64) undifferentiated beaked whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Anon. 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for *g(0)* or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 1,519 (CV=0.69) undifferentiated beaked whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Palka *et al.* Unpubl. Ms.). Total track line length was 32,600km. The ships covered waters between the 50 and 1,000 fathom isobaths, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom isobath, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom isobath. Data collection and analysis methods used were described in Palka (1996).

An abundance of 2,600 (CV=0.40) undifferentiated beaked whales was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* Unpubl. Ms.). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)*.

An abundance of 541 (CV=0.55) undifferentiated beaked whales was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 4,163 km of track line in waters south of Maryland (38°N) (Figure 1; Mullin and Fulling 2003). This estimate is a recalculation of the same data reported in previous SARs. For more details see Mullin and Fulling (2003). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993) where school size bias and ship attraction were accounted for.

The best 1998 abundance estimate for undifferentiated beaked whales is the sum of the estimates from the two U.S. Atlantic surveys, 3,141 (CV=0.34), where the estimate from the northern U.S. Atlantic is 2,600 (CV=0.40) and from the southern U.S. Atlantic is 541 (CV=0.55). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

An abundance of 2,167 (CV=0.587) for beaked whales was estimated from a line-transect sighting survey conducted during June 12 to August 4, 2004 by a ship and plane that surveyed 10,761 km of track line in waters north of Maryland (about 38° N) to the Bay of Fundy (about 45° N) (Figure 1; Palka unpubl.). Shipboard data were collected using the two independent team line transect method and analyzed using the modified direct duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and g(0), the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line-transect method (Hiby 1999) and analyzed accounting for g(0) and biases due to school size and other potential covariates (Figure 1; Palka unpubl.).

A shipboard survey of the U.S. Atlantic outer continental shelf and continental slope (water depths ≥ 50m) between Florida and Maryland (27.5 and 38^0N latitude was conducted during June-August, 2004. The survey employed two independent visual teams searching with 50x bigeye binocluars. Survey effort was stratified to include increased effort along the continental shelf break and Gulf stream front in the mid-Atlantic. The survey included 5,659 km of trackline, and there were a total of 473 cetacean sightings. Sightings were most frequent in waters north of Cape Hatteras, North Carolina along the shelf break. Data were analyzed to correct for visibility bias (*g(0)*) and group-size bias employing line transect distance analysis and the direct duplicate estimator (Palka, 1995; Buckland *et al.*, 2001). The resulting abundance estimate for beaked whales between Florida and Maryland was 674 (CV =0.362).

The best 2004 abundance estimate for beaked whales is the sum of the estimates from the two 2004 U.S. Atlantic surveys, 2,841 (CV =0.456), where the estimate from the northern U.S. Atlantic is 2,167 (CV =0.587) , and from the southern U.S. Atlantic is 674 (CV =0.362). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Although the 1990-2004 surveys did not sample exactly the same areas or encompass the entire beaked whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective 1990-2004 data suggest that, seasonally, at least several thousand beaked whales are occupying these waters, with highest levels of abundance in the Georges Bank region. Recent results suggest that beaked whale abundance may be highest in association with Gulf Stream and warm-core ring features.

Because the estimates presented here were not dive-time corrected, they are likely negatively biased and probably underestimate actual abundance. Given that *Mesoplodon* spp. prefers deep-water habitats (Mead 1989) the bias may be substantial.

Table 1. Summary of abundance estimates for the undifferentiated complex of beaked whales which include *Ziphius* and *Mesoplodon* spp. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	2,600	0.40
Jul-Aug 1998	Florida to Maryland	541	0.55
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	3,141	0.34
Jun-Aug 2004	Maryland to the Bay of Fundy	2,167	0.59
Jun-Aug 2004	Florida to Maryland	674	0.36
Jun-Aug 2004	Bay of Fundy to Florida	2,841	0.46

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for undifferentiated beaked whales is 2,841 (CV =0.46). The minimum population estimate for the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 1,971. It is not possible to determine the minimum population estimate of only Cuvier's beaked whales.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: length at birth is 2 to 3m, length at sexual maturity is 6.1m for females, and 5.5m for males, maximum age for females were 30 growth layer groups (GLG's) and for males was 36 GLG's, which may be annual layers (Mitchell 1975; Mead 1984; Houston 1990).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the undifferentiated complex of beaked whales is ,1,971. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for all species in the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 20. It is not possible to determine the PBR for only Cuvier's beaked whales.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 1999-2003 total average estimated annual mortality of beaked whales in fisheries in the U.S. Atlantic EEZ was 1.0 and is derived from three components: 1) two stranded animals were entangled in fishing gear, 2) two animals were ship struck, and 3) one stranded animal died from acoustic or blunt trauma - see other mortality text and (Table 2).

Fishery Information

Total fishery-related mortality and serious injury cannot be estimated separately for each beaked whale species because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review

Group advised adopting the risk-averse strategy of assuming that any beaked whale stock which occurred in the U.S. Atlantic EEZ might have been subject to the observed fishery-related mortality and serious injury.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, Northeast multispecies sink gillnet, mid-Atlantic coastal gillnet, or North Atlantic bottom trawl fisheries by NMFS Sea Samplers. Detailed fishery information are reported in Appendix III.

Earlier Interactions

There is no historical information available that documents incidental mortality of beaked whales in either U.S. or Canadian Atlantic coast fisheries (Read 1994). The only documented bycatch of beaked whales is in the pelagic drift gillnet fishery (now prohibited). The bycatch only occurred from Georges Canyon to Hydrographer Canyon along the continental shelf break and continental slope during July to October. Forty-six fishery-related beaked whale mortalities were observed between 1989 and 1998. These included 24 Sowerby's, 4 True's, 1 Cuvier's and 17 undifferentiated beaked whales. Recent analysis of biological samples (genetics and morphological analysis) have been used to determine species identifications for some of the bycaught animals. Estimation of bycatch mortalities by species are available for the 1994-1998 period. Prior estimates are for undifferentiated beaked whales. The estimated annual fishery-related mortality (CV in parentheses) was 60 in 1989 (0.21), 76 in 1990 (0.26), 13 in 1991 (0.21), 9.7 in 1992 (0.24) and 12 in 1993 (0.16). The 1994-1998 estimates by 'species' are:

Year	Cuvier's	Sowerby's	True's	*Mesoplodon* spp.
1994	1 (0.14)	3 (0.09)	0	0
1995	0	6 (0)	1 (0)	3 (0)
1996	0	9 (0.12)	2 (0.26)	2 (0.25)
1997	NA	NA	NA	NA
1998	0	2 (0)	2 (0)	7 (0)

During July 1996, one beaked whale was entangled and released alive with "gear in/around a single body part". Annual mortality estimates do not include any animals injured and released alive.

Other Mortality

From 1992 to 2000, a total of 53 beaked whales stranded along the U.S. Atlantic coast between Florida and Massachusetts (NMFS unpublished data). This includes: 28 (includes one tentative identification) Gervais' beaked whales (one 1997 animal had plastics in esophagus and stomach, and Sargassum in esophagus; 2 animals that stranded in September 1998 in South Carolina showed signs of fishery interactions); 2 True's beaked whales; 5 Blainville's beaked whales; 1 Sowerby's beaked whale; 13 Cuvier's beaked whales (one 1996 animal had propeller marks, and one 2000 animal had a longline hook in the lower jaw) and 4 unidentified animals.

One stranding of Sowerby's beaked whale was recorded on Sable Island between 1970-1998 (Lucas and Hooker 2000). The whale's body was marked by wounds made by the cookiecutter shark (*Isistius brasiliensis*), which has previously been observed on beaked whales (Lucas and Hooker 2000).

Also, several unusual mass strandings of beaked whales in North Atlantic marine environments have been associated with Naval activities. During the mid- to late 1980's multiple mass strandings of Cuvier's beaked whales (4 to about 20 per event) and small numbers of Gervais' beaked whale and Blainville's beaked whale occurred in the Canary Islands (Simmonds and Lopez-Jurado 1991). Twelve Cuvier's beaked whales that live stranded and subsequently died in the Mediterranean Sea on 12-13 May 1996 were associated with low frequency acoustic sonar tests conducted by the North Atlantic Treaty Organization (Frantzis 1998). In March 2000, 14 beaked whales live stranded in the Bahamas; 6 beaked whales (5 Cuvier's and 1 Blainville's) died (Balcomb and Claridge 2001; Evans and England 2001; Cox *et al.*, in review). Four Cuvier's, 2 Blainville's and 2 unidentified beaked whales were returned to sea. The fate of the animals returned to sea is unknown, since none of the whales have been resighted. Necropsies of 6 dead beaked whales revealed evidence of tissue trauma associated with an acoustic or impulse injury that caused the animals to strand. Subsequently, the animals died due to extreme physiologic stress associated with the physical stranding (i.e., hyperthermia, high endogenous catecholamine release) (Anon. 2002). During 2001-2003, twenty-four beaked whales stranded along the U.S. Atlantic coast (Table 2).

Table 2. Beaked whale (*Ziphius cavirostris* and *Mesoplodon* sp.) reported strandings along the U.S. Atlantic coast.

State	2001	2002	2003	Total
Maine	0	*M. mirus* (1)	*M. bidens* (1)[3]	2
Massachusetts	0	0	0	0
Virginia	0	*M. Europaeus* (2)[2]	*M. mirus* (1)[4]	3
North Carolina	*M. europaeus* (1) *Mesoplodon* sp. (3)	Unid. (1)	*M. europeaus* (2); *Mesoplodon* sp. (1)	9
South Carolina	*M. europaeus* (2)	*Ziphius* (1)	*Ziphius* (2)	5
Florida	*M. europaeus* (4[1])	0	*Ziphius* (1); *M. europaeus* (1)	5
Total	10	5	9	24[5]

[1] Acoustic or blunt trauma was the assigned cause of mortality for one animal stranded in Broward County in Sept.
[2] Ship strike was the likely cause of death for one animal
[3] Boat strike was the likely cause of death
[4] Entanglement in fishing gear was the likely cause of death
[5] The cause of death for most of the stranded animals could not be determined.

STATUS OF STOCK

The status of Cuvier's beaked whale relative to OSP in the U.S. Atlantic EEZ is unknown. This species is not listed as threatened or endangered under the Endangered Species Act. Although a species specific PBR cannot be determined, the permanent closure of the pelagic drift gillnet fishery has eliminated the principal known source of incidental fishery mortality. The total fishery mortality and serious injury for this group is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because of uncertainty regarding stock size and evidence of human induced mortality and serious injury associated with acoustic activities.

REFERENCES

Anon. 1990. Cruise results, NOAA Ship CHAPMAN, Cruise No. 90-05. Marine Mammal Sighting Survey. 5pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA-NMFS-SEFSC and NEFSC. 4 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. 5 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1994. Cruise results, NOAA Ship RELENTLESS, Cruise No. RS 94-02, Marine Mammal Survey/Warm Core Ring Study. 8pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Balcomb, K. C. III and D. E. Claridge. 2001. A mass stranding of cetaceans caused by naval sonar in the Bahamas. *Bahamas J. Sci.* 2:2-12.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Anderson, K. P. Burnham and J. L. Laake. 1993. Distance sampling: estimating abundance of biological populations. *Chapman and Hall*, New York, NY, 442 pp.

Buckland, S. T., D.R. Andersen, K.P Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling estimating abundance of biological populations. *Oxford University Press*, New York, 432 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Cox, T.M., T. Ragen, A.J. Read, E. Vos, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernadez, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P.D. Jepson, D. Ketten, C.D. MacLeod, P. Miller, S. Moore, D. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead, L. Benner. 2004. Report of a workshop to understand the impacts of anthropogenic sound on beaked whales. 33 pp. Submitted to J. Cetacean Res. Manage.

Frantzis, A. 1998. Does acoustic testing strand whales? *Nature* 392:29.

Evans, D.L. and G. R. England. 2001. Joint interim report - Bahamas Marine Mammal Stranding - event of 15-16 March 2000. U.S. Department of Commerce; Secretary of the Navy, vi + 59 pp. Available at: http://www.nmfs.noaa.gov/pr/acoustics/acoustics_reports.htm.

Heyning, J. E. 1989. Cuvier's beaked whale, *Ziphius cavirostris* G. Cuvier, 1823. Pages 289-308 *In*: S. H. Ridgway and R. Harrison (eds), Handbook of Marine Mammals, Vol. 4: River dolphins and larger toothed whales. *Academic Press*, London, 442 pp.

Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 *in*: Garner *et al.* (eds). Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.

Houston, J. 1990. Status of Cuvier's Beaked Whale, *Ziphius cavirostris*, in Canada. *Can. Fld. Nat.* 105(2): 215-218.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Mead, J. G. 1984. Survey of reproductive data for the beaked whales (*Ziphiidae*). *Rep. int Whal. Commn.* (Special Issue 6): 91-96.

Mead, J.G. 1989. Beaked whales of the genus *Mesoplodon*. Pages 349-430. *In:* S.H. Ridgeway and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 4: River Dolphins and Toothed Whales. *Academic Press*, San Diego, CA, 442 pp.

Mignucci-Giannoni, A. A., B. Pinto-Rodríguez, M. Velasco-Escudero, R. A. Montoya-Ospina, N. M. Jiménez, M.A. Rodríguez-López, E. H. Williams, Jr., and D. K. Odell. 1999. Cetacean strandings in Puerto Rico and the Virgin Islands. *J. Cetacean Res. Manage*. 1:191-198.

Mitchell, E. D. (ed). 1975. Review of the biology and fisheries for smaller cetaceans. Report of the meeting on smaller cetaceans. Int Whal. Commn. *J. Fish. Res. Bd. Can.* 32(7): 875-1240.

Mullin, K. D. and G. L. Fulling. 2003. Abundance of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. *Fish. Bull., U.S.*101:603-613.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. *Rep. int Whal. Commn. (*Special Issue *16):27-50.*

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Palka, D. and Hammond, P.S. 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci. 58: 777-787.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the Northwest Atlantic. *Rep. int Whal. Commn*. *(*Special Issue *15): 133-147.*

Simmonds, M. P. and L. F. Lopez-Jurado. 1991. Whales and the military. *Nature* 351:448.

Wade, P. R., and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam, and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES C.M.* 1992/N:12 29 pp.

Waring, G. T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA-NMFS-NEFSC Lab. Ref. Doc. No. 98-09, 21 pp. Available from: National Marine Fisheries Service, 166 Water St., Woods Hole, Massachusetts 02543-1026.

Waring, G.T., T. Hamazaki, D. Sheehan, G. Wood, and S. Baker. 2001. Characterization of beaked whale (Ziphiidae) and sperm whale (*Physeter macrocephalus*) summer habitat in shelf-edge and deeper waters off the northeast U.S. *Mar. Mammal Sci*. 17(4): 703-717.

HARBOR PORPOISE (*Phocoena phocoena)*: Gulf of Maine/Bay of Fundy Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

This stock is found in U.S. and Canadian Atlantic waters. The distribution of harbor porpoises has been documented by sighting surveys, strandings and takes reported by NMFS observers in the Sea Sampling Program. During summer (July to September), harbor porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy region, generally in waters less than 150m deep (Gaskin 1977; Kraus et al. 1983; Palka 1995a, b), with a few sightings in the upper Bay of Fundy and on the northern edge of Georges Bank (Palka 2000). During fall (October-December) and spring (April-June), harbor porpoises are widely dispersed from New Jersey to Maine, with lower densities farther north and south. They are seen from the coastline to deep waters (>1800m; Westgate et al. 1998), although the majority of the population is found over the continental shelf. During winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada. There does not appear to be a temporally coordinated migration or a specific migratory route to and from the Bay of Fundy region. However, during the fall, several satellite tagged harbor porpoises did favor the waters around the 92m isobath, which is consistent with observations of high rates of incidental catches in this depth range (Read and Westgate 1997). There were two stranding records from Florida during the 1980's (Smithsonian strandings database) and one during 2003 (NE Regional Office/NMFS strandings and entanglement database).

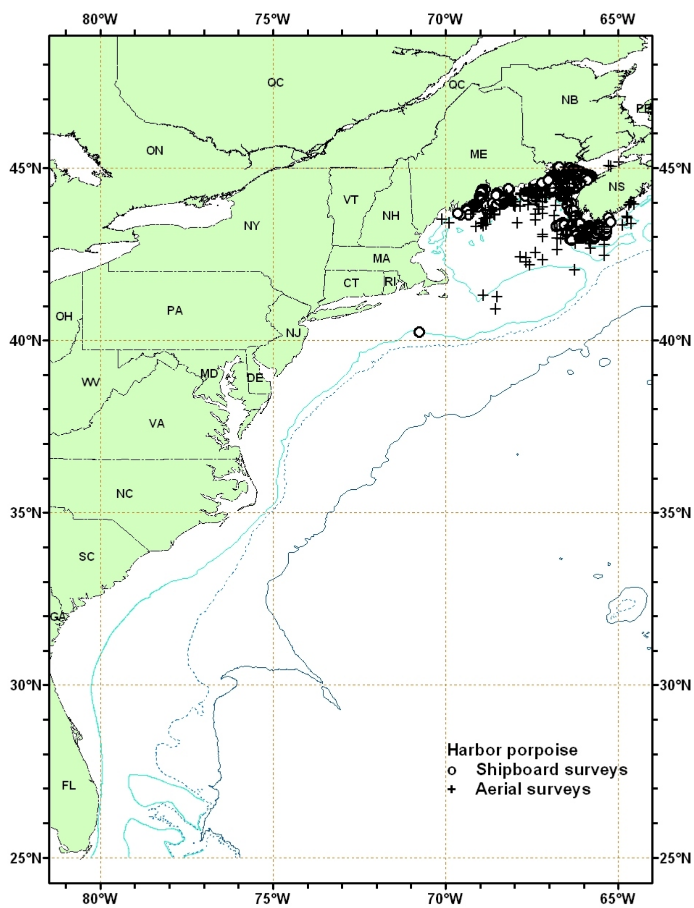

Figure 1. *Distribution of harbor porpoises from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, and 2004. Isobaths are the 100m, 1000m, and 4000m depth contours.*

Gaskin (1984, 1992) proposed that there were four separate populations in the western North Atlantic: the Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland and Greenland populations. Recent analyses involving mtDNA (Wang et al. 1996; Rosel et al. 1999a, 1999b), organochlorine contaminants (Westgate et al.1997; Westgate and Tolley 1999), heavy metals (Johnston 1995), and life history parameters (Read and Hohn 1995) support Gaskin's proposal. Genetic studies using mitochondrial DNA (Rosel et al. 1999a) and contaminant studies using total PCBs (Westgate and Tolley 1999) indicate that the Gulf of Maine/Bay of Fundy females were distinct from females from the other populations in the Northwest Atlantic. Gulf of Maine/Bay of Fundy males were distinct from Newfoundland and Greenland males, but not from Gulf of St. Lawrence males according to studies comparing mtDNA (Rosel et al. 1999a; Palka et al. 1996) and CHLORs, DDTs, PCBs and CHBs (Westgate and Tolley 1999). Analyses of stranded animals from the mid-Atlantic states suggest that this aggregation of harbor porpoises consists of animals from more than just the Gulf of Maine/Bay of Fundy stock (Rosel et al. 1999a). However, the majority of the samples used in the Rosel et al.

(1999a) study were from stranded juvenile animals. Further work is needed to examine adult animals from this region. Nuclear microsatellite markers have also been applied to samples from these four populations, but this analysis failed to detect significant population sub-division in either sex (Rosel et al. 1999a). This pattern may be indicative of female philopatry coupled with dispersal of males. This report follows Gaskin's hypothesis on harbor porpoise stock structure in the western North Atlantic; Gulf of Maine and Bay of Fundy harbor porpoises are recognized as a single management stock separate from harbor porpoise populations in the Gulf of St. Lawrence, Newfoundland and Greenland.

POPULATION SIZE

To estimate the population size of harbor porpoises in the Gulf of Maine/Bay of Fundy region, four line-transect sighting surveys were conducted during the summers of 1991, 1992, 1995 and 1999 (Table 1; Figure 1). The estimates were 37,500 harbor porpoises in 1991 (CV=0.29, 95% confidence interval (CI)=26,700-86,400) (Palka 1995a), 67,500 harbor porpoises in 1992 (CV=0.23, 95% CI=32,900-104,600), 74,000 harbor porpoises in 1995 (CV=0.20, 95% CI=40,900-109,100) (Palka 1996) and 89,700 in 1999 (CV=0.22, 95% CI=53,400-150,900) (Palka 2000). The inverse variance weighted-average abundance estimate (Smith et al. 1993) of the 1991 to 1995 estimates was 54,300 harbor porpoises (CV=0.14, 95% CI=41,300-71,400). Possible reasons for inter-annual differences in abundance and distribution include experimental error, inter-annual changes in water temperature and availability of primary prey species (Palka 1995b), and movement among population units (e.g., between the Gulf of Maine and Gulf of St. Lawrence). One of the reasons the 1999 estimate is larger than previous estimates is that, for the first time, the upper Bay of Fundy and northern Georges Bank were surveyed and harbor porpoises were seen in both areas. This indicates the harbor porpoise summer habitat is larger than previously thought (Palka 2000).

The shipboard sighting survey procedure used in all four surveys involved two independent teams on one ship that searched using the naked eye in non-closing mode. Abundance, corrected for *g(0)*, the probability of detecting an animal group on the track line, was estimated using the direct-duplicate method (Palka 1995a) and variability was estimated using bootstrap re-sampling methods. Potential biases not explicitly accounted for include ship avoidance and submergence time. The effects of these two potential biases are unknown. During 1995 and 1999 a section of the region was surveyed by airplane while the rest of the region was surveyed by ship, as in previous years (Palka 1996; 2000). During 1995, in addition to the Gulf of Maine/Bay of Fundy area, waters from Virginia to the mouth of the Gulf of St. Lawrence were surveyed and harbor porpoises were seen only in the vicinity of the Gulf of Maine/Bay of Fundy. During 1999, waters from south of Cape Cod to the mouth of the Gulf of St. Lawrence were surveyed (Palka 2000).

The best current abundance estimate of the Gulf of Maine/Bay of Fundy harbor porpoise stock is 89,700 (CV=0.22), based on the 1999 survey results not averaged with other years (Table 1). This is because the 1999 estimate is the most current, and this survey discovered portions of the harbor porpoise range not covered previously.

Kingsley and Reeves (1998) estimated there were 12,100 (CV=0.26) harbor porpoises in the entire Gulf of St. Lawrence during 1995, and 21,700 (CV=0.38) in the northern Gulf of St. Lawrence during 1996. These estimates are presumed to be of the Gulf of St. Lawrence stock of harbor porpoises. The highest densities were north of Anticosti Island, with lower densities in the central and southern Gulf. During the 1995 survey, 8,427km of track lines were flown in an area of 221,949km^2 during August and September. During the 1996 survey, 3,993km of track lines were flown in an area of 94,665km^2 during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line transect methods that modeled the left truncated sighting curve. These estimates were not corrected for visibility biases such as *g(0)*.

Table 1. Summary of recent abundance estimates for the Gulf of Maine/Bay of Fundy harbor porpoise. Month, year, and area covered during each abundance survey and the resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Aug 1999	S. Gulf of Maine to upper Bay of Fundy	89,700	0.22

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for harbor porpoises is 89,700 (CV=0.22). The minimum population estimate for the Gulf of Maine/Bay of Fundy harbor porpoise is 74,695.

Current Population Trend

Previous abundance estimates for harbor porpoises in the Gulf of Maine/Bay of Fundy are available from earlier studies, (e.g., 4,000 animals (Gaskin 1977), and 15,800 animals (Kraus et al. 1983)). These estimates cannot be used in a trends analysis because they were for selected small regions within the entire known summer range and, in some cases, did not incorporate an estimate of *g(0)* (NEFSC 1992).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Although current population growth rates of Gulf of Maine/Bay of Fundy harbor porpoises have not been estimated due to lack of data, several attempts have been made to estimate potential population growth rates. Barlow and Boveng (1991), who used a re-scaled human life table, estimated the upper bound of the annual potential growth rate to be 9.4%. Woodley and Read (1991) used a re-scaled Himalayan tahr life table to estimate a likely annual growth rate of 4%. In an attempt to estimate a potential population growth rate that incorporates many of the uncertainties in survivorship and reproduction, Caswell et al. (1998) used a Monte Carlo method to calculate a probability distribution of growth rates. The median potential annual rate of increase was approximately 10%, with a 90% confidence interval of 3-15%. This analysis underscored the considerable uncertainty that exists regarding the potential rate of increase in this population. Consequently, for the purposes of this assessment, the maximum net productivity rate was assumed to be 4%, consistent with values used for other cetaceans for which direct observations of maximum rate of increase are not available, and following a recommendation from the Atlantic Scientific Review Group. The 4% value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow et al. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 74,695. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the Gulf of Maine/Bay of Fundy harbor porpoise is 747.

ANNUAL HUMAN-CAUSED MORTALITY

Data to estimate the mortality and serious injury of harbor porpoise come from U.S. and Canadian Sea Sampling Programs, from records of strandings in U.S. and Canadian waters, and from records in the Marine Mammal Authorization Program (MMAP). See Appendix III for details on U.S. fisheries and data sources. Estimates using Sea Sampling Program and MMAP data are discussed by fishery under the Fishery Information section (Table 2). Strandings records are discussed under the Unknown Fishery in the Fishery Information section (Table 3) and under the Other Mortality section (Tables 4 to 5).

A take reduction plan was implemented 01 January 1999 to reduce takes of harbor porpoises in U.S. Atlantic gillnet fisheries. In addition, several New England and mid-Atlantic Fishery Management Council plans that apply to parts of the gillnet fisheries were also implemented during 1999. Because these plans changed the U.S. gillnet fisheries, only mortality estimates from after 1999 are representative of the current U.S. mortality.

The total annual estimated average human-caused mortality is 477 (CV=0.17) harbor porpoises per year. This is derived from four components: 417 harbor porpoise per year (CV=0.17) from U.S. fisheries using observer and MMAP data, 48 per year (unknown CV) from Canadian fisheries using observer data, 10.4 per year from U.S. unknown fisheries using strandings data, and 1.4 per year from unknown human-caused mortality (mutilated stranded harbor porpoises).

Fishery Information

Recently, Gulf of Maine/Bay of Fundy harbor porpoise takes have been documented in the U.S. Northeast sink gillnet, mid-Atlantic coastal gillnet, and in the Canadian Bay of Fundy groundfish sink gillnet and herring weir fisheries (Table 2). Detailed U.S. fishery information are reported in Appendix III.

Earlier Interactions

One harbor porpoise was observed taken from the Atlantic pelagic drift gillnet fishery during 1991-1998, at which time the fishery ended. This observed bycatch was notable because it occurred in continental shelf edge waters adjacent to Cape Hatteras (Read et al. 1996). Estimated annual fishery-related mortality (CV in parentheses) attributable to this fishery was 0.7 in 1989 (7.00), 1.7 in 1990 (2.65), 0.7 in 1991 (1.00), 0.4 in 1992 (1.00), 1.5 in 1993 (0.34), 0 during 1994-1996 and 0 in 1998. The fishery was closed during 1997.

U.S.

Northeast Sink Gillnet

In 1984 the Northeast sink gillnet fishery was investigated by a sampling program that collected information concerning marine mammal bycatch. Approximately 10% of the vessels fishing in Maine, New Hampshire, and Massachusetts were sampled. Among the 11 gillnetters who received permits and logbooks, 30 harbor porpoises were reported caught. It was estimated, using rough estimates of fishing effort, that a maximum of 600 harbor porpoises were killed annually in this fishery (Gilbert and Wynne 1985, 1987).

In 1990, an observer program was started by NMFS to investigate marine mammal takes in the Northeast sink gillnet fishery (Appendix III). There have been 474 harbor porpoise mortalities related to this fishery observed between 1990 and 2003 and one was released alive and uninjured. Bycatch in the northern Gulf of Maine occurs primarily from June to September, while in the southern Gulf of Maine, bycatch occurs from January to May and September to December. Estimated annual bycatch (CV in parentheses) from this fishery during 1990-2003 was 2,900 in 1990 (0.32), 2,000 in 1991 (0.35), 1,200 in 1992 (0.21), 1,400 in 1993 (0.18) (Bravington and Bisack 1996; CUD 1994), 2,100 in 1994 (0.18), 1,400 in 1995 (0.27) (Bisack 1997), 1,200 in 1996 (0.25), 782 in 1997 (0.22), 332 in 1998 (0.46), 270 in 1999 (0.28) (Rossman and Merrick 1999), 507 in 2000 (0.37), 51 (0.97) in 2001, 444 (0.37) in 2002 and 592 (0.33) in 2003. The increase in the CV in recent years is mainly due to the small number of observed takes.

In November 2001, there were two takes reported through the Marine Mammal Authorization Program (MMAP) that were taken in one sink gillnet haul located near Jeffery's Ledge. These two takes were then added to the 2 observed takes and 51 estimated total take that was derived from the observer data because the MMAP takes were in a time and area not included in any of the above observer-based bycatch estimates. This then results in 4 observed takes and 53 (0.97) total takes in 2001 from this fishery (Table 2).

There appeared to be no evidence of differential mortality in U.S. or Canadian gillnet fisheries by age or sex in animals collected before 1994, although there was substantial inter-annual variation in the age and sex composition of the bycatch (Read and Hohn 1995). Using observer data collected during 1990-1998 and a logit regression model, females were 11 times more likely to be caught in the offshore southern Gulf of Maine region, males were more likely to be caught in the south Cape Cod region, and the overall proportion of males and females caught in a gillnet and brought back to land were not significantly different from 1:1 (Lamb 2000).

Two preliminary experiments, using acoustic alarms (pingers) attached to gillnets, were conducted in the Gulf of Maine during 1992 and 1993 and took 10 and 33 harbor porpoises, respectively. During fall 1994, another controlled scientific experiment was conducted in the southern Gulf of Maine, where 25 harbor porpoises were taken in 423 strings with non-active pingers (controls) and 2 harbor porpoises were taken in 421 strings with active pingers (Kraus et al. 1997). In addition, 17 other harbor porpoises were taken in nets that did not follow the experimental protocol (Table 2). After 1994, experimental fisheries were conducted where all nets in a designated area were required to use pingers and only a sample of the nets were observed. During November-December 1995, an experimental fishery was conducted in the southern Gulf of Maine (Jeffreys Ledge) region, where no harbor porpoises were observed taken in 225 pingered nets. During 1995, all takes from pingered nets were added directly to the estimated total bycatch for that year. During April 1996, 3 other experimental fisheries occurred. In the

Jeffreys Ledge area, in 88 observed hauls using pingered nets, 9 harbor porpoises were taken. In the Massachusetts Bay region, in 171 observed hauls using pingered nets, 2 harbor porpoises were taken. And, in a region just south of Cape Cod, in 53 observed hauls using pingered nets, no harbor porpoises were taken. During 1997, experimental fisheries were allowed in the mid-coast region during March 25 to April 25 and November 1 to December 31. During the 1997 spring experimental fishery, 180 hauls were observed with active pingers and 220 hauls were controls (silent). All observed harbor porpoise takes were in silent nets: 8 in nets with control (silent) pingers and 3 in nets without pingers. Thus, there was a statistical difference between the catch rate in nets with pingers and silent nets (Kraus and Brault 1997). During the 1997 fall experimental fishery, out of 125 observed hauls using pingered nets no harbor porpoises were taken.

From 95 stomachs of harbor porpoises collected in groundfish gillnets in the Gulf of Maine between September and December 1989-1994, Atlantic herring (*Clupea harengus*) was the most important prey. Pearlsides (*Maurolicus weitzmani*), silver hake (*Merluccius bilinearis*) and red and white hake (*Urophycis* spp.) were the next most common prey species (Gannon et al. 1998).

Average estimated harbor porpoise mortality and serious injury in the Northeast sink gillnet fishery during 1994-1998 before the Take Reduction Plan, was 1,163 (0.11). Because of the Take Reduction Plan to reduce takes in U.S. Atlantic gillnets, and the NEFMC fishery management plans to manage groundfish, fishing practices changed during 1999. Subsequently, the average annual harbor porpoise mortality and serious injury in the Northeast sink gillnet fishery from 1999 to 2003 was 373 (0.18) (Table 2).

Mid-Atlantic Coastal Gillnet

Before an observer program was in place for this fishery, Polacheck et al. (1995) reported one harbor porpoise incidentally taken in shad nets in the York River, Virginia. In July 1993 an observer program was initiated in the mid-Atlantic coastal gillnet fishery by the NEFSC Sea Sampling program (Appendix III). Documented bycatch after 1995 were from December to May. Bycatch estimates were calculated using methods similar to that used for bycatch estimates in the Northeast gillnet fishery (Bravington and Bisack 1996; Bisack 1997). After 1998, a separate bycatch estimate was made for the drift gillnet and set gillnet sub-fisheries. The number presented here is the sum of these two sub-fisheries. The estimated annual mortality (CV in parentheses) attributed to this fishery was 103 (0.57) for 1995, 311 (0.31) for 1996, 572 (0.35) for 1997, 446 (0.36) for 1998, 53 (0.49) for 1999, 21 (0.76) for 2000, 26 (0.95) for 2001, unknown in 2002 and 76 (1.13) in 2003. During 2002, the overall observer coverage was lower than usual, 1%, where 65% of that coverage was off of Virginia, and most of the rest of the area was not sampled at all. Thus, due to this non-representative and low observer coverage, a bycatch estimate for harbor porpoises cannot be confidently estimated. Annual average estimated harbor porpoise mortality and serious injury from the mid-Atlantic coastal gillnet fishery during 1995 to 1998, before the Take Reduction Plan, was 358 (CV=0.20). Because of the Take Reduction Plan to reduce takes in U.S. Atlantic gillnets, and the fishery management plans to manage groundfish, fishing practices changed during 1999. Subsequently, the average annual harbor porpoise mortality and serious injury in the mid-Atlantic coastal gillnet fishery from 1999 to 2003 was 44 (0.61), which is the 4-year average estimate from 1999, 2000, 2001, and 2003.

Unknown Fishery

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, reported 228, 27, 113, 79, and 122 stranded harbor porpoises on U.S. beaches during 1999 to 2003, respectively (see Other Mortality section for more details). Of these, it was determined that the cause of death of 19, 1, 3, 2, and 27 stranded harbor porpoises in 1999 to 2003, respectively, were due to unknown fisheries (Tables 3 and 5) and these animals were in areas and times that were not included in the above mortality estimate derived from observer program data. The average harbor porpoise mortality and serious injury in this unknown fishery category from 1999 to 2003 is 10.4 (CV is unknown).

North Atlantic Bottom Trawl

This fishery is active in New England waters in all seasons. Two harbor porpoise mortalities were observed in the North Atlantic bottom trawl fishery between 1989 and 2003. The first take occurred in February 1992 east of Barnegat Inlet, New Jersey at the continental shelf break. The animal was clearly dead prior to being taken by the trawl, because it was severely decomposed and the tow duration of 3.3 hours was insufficient to allow extensive decomposition. The second take occurred in January 2001 off New Hampshire in a haul trawling for flounder. This animal was clearly dead prior to being taken by the trawl, because it was severely decomposed (the skull broke off while the net was emptying) and the tow duration was 3.1 hours. This take was observed in the same time and area stratum that had documented gillnet takes. In conclusion, the estimated bycatch of harbor porpoises due to this fishery is 0.

CANADA

Hooker et al. (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on 25-40% of large Canadian fishing vessels (greater than 100 feet long), and on approximately 5% of smaller Canadian fishing vessels. No harbor porpoises were observed taken.

Bay of Fundy Sink Gillnet

During the early 1980's, Canadian harbor porpoise bycatch in the Bay of Fundy sink gillnet fishery, based on casual observations and discussions with fishermen, was thought to be low. The estimated harbor porpoise bycatch in 1986 was 94-116 and in 1989 it was 130 (Trippel et al. 1996). The Canadian gillnet fishery occurs mostly in the western portion of the Bay of Fundy during the summer and early autumn months, when the density of harbor porpoises is highest. Polacheck (1989) reported there were 19 gillnetters active in 1986, 28 active in 1987, and 21 in 1988.

More recently, an observer program implemented in the summer of 1993 provided a total bycatch estimate of 424 harbor porpoises (± 1 SE: 200-648) from 62 observed trips, (approximately 11.3% coverage of the Bay of Fundy trips) (Trippel et al. 1996).

During 1994, the observer program was expanded to cover 49% of the gillnet trips (171 observed trips). The bycatch was estimated to be 101 harbor porpoises (95% confidence limit: 80-122), and the fishing fleet consisted of 28 vessels (Trippel et al. 1996).

During 1995, due to groundfish quotas being exceeded, the gillnet fishery was closed from July 21 to August 31. During the open fishing period of 1995, 89% of the trips were observed, all in the Swallowtail region. Approximately 30% of these observed trips used pingered nets. The estimated bycatch was 87 harbor porpoises (Trippel et al. 1996). No confidence interval was computed due to lack of coverage in the Wolves fishing grounds.

During 1996, the Canadian gillnet fishery was closed during July 20-31 and August 16-31 due to groundfish quotas. From the 107 monitored trips, the bycatch in 1996 was estimated to be 20 harbor porpoises (Trippel et al. 1999; DFO 1998). Trippel et al. (1999) estimated that during 1996, gillnets equipped with acoustic alarms reduced harbor porpoise bycatch rates by 68% over nets without alarms in the Swallowtail area of the lower Bay of Fundy.

During 1997, the fishery was closed to the majority of the gillnet fleet during July 18-31 and August 16-31, due to groundfish quotas. In addition a time-area closure to reduce porpoise bycatch in the Swallowtail area occurred during September 1-7. From the 75 monitored trips, 19 harbor porpoises were observed taken. After accounting for total fishing effort, the estimated bycatch in 1997 was 43 animals (DFO 1998). Trippel et al. (1999) estimated that during 1997, gillnets equipped with acoustic alarms reduced harbor porpoise bycatch rates by 85% over nets without alarms in the Swallowtail area of the lower Bay of Fundy.

The number of monitored trips (and observed harbor porpoise mortalities were 111 (5) for 1998, 93 (3) for 1999, 194 (5) for 2000, and 285 (39) for 2001. The estimated annual mortality estimates were 38 for 1998, 32 for 1999, 28 for 2000, and 73 for 2001 (Trippel and Shepard, in press). Estimates of variance are not available. There was no observer program during the summers of 2002 and 2003 in the Bay of Fundy region, but the fishery was active. Thus, it is not known what the bycatch for these two years.

The three-year average estimated harbor porpoise mortality in the Canadian groundfish sink gillnet fishery during 1999-2001 was 44 (Table 2). An estimate of variance is not possible.

Herring Weirs

Harbor porpoises are taken in Canadian herring weirs, but there have been no recent efforts to observe takes in the U.S. component of this fishery. Smith et al. (1983) estimated that in the 1980's approximately 70 harbor porpoises became trapped annually and, on average, 27 died annually. In 1990, at least 43 harbor porpoises were trapped in Bay of Fundy weirs (Read 1994). In 1993, after a cooperative program between fishermen and Canadian biologists was initiated, over 100 harbor porpoises were released alive (Read 1994). Between 1992 and 1994, this cooperative program resulted in the live release of 206 of 263 harbor porpoises caught in herring weirs. Mortalities (and releases) were 11 (and 50) in 1992, 33 (and 113) in 1993, and 13 (and 43) in 1994 (Neimanis et al. 1995). Since that time, an additional 623 harbor porpoises have been documented in Canadian herring weirs, of which 584 were released or escaped, 32 died, and 7 had an unknown status. Mortalities (and releases and unknowns) were 5 (and 60) in 1995; 2 (and 4) in 1996; 2 (and 24) in 1997; 2 (and 26) in 1998; 3 (and 89) in 1999; 0 (and 13) in 2000 (A. Read, pers. comm), 14 (and 296) in 2001, 3 (and 46 and 4) in 2002, and 1 (and 26 and 3) in 2003 (H. Koopman, pers. comm.).

Clinical hematology values were obtained from 29 harbor porpoises released from Bay of Fundy herring weirs (Koopman et al. 1999). These data represent a baseline for free-ranging harbor porpoises that can be used as a reference for long-term monitoring of the health of this population, a mandate by the MMPA. Blood for both hematology and serum chemistry, including stress and reproductive hormones, is currently being collected; with 57 samples from 2001, 15 from 2002 and 7 from 2003 (H. Koopman, pers. comm).

Average estimated harbor porpoise mortality in the Canadian herring weir fishery during 1999-2003 was 4.2 (Table 2). An estimate of variance is not possible.

Gulf of St. Lawrence gillnet

This fishery interacts with the Gulf of St. Lawrence harbor porpoise stock, not the Gulf of Maine/Bay of Fundy harbor porpoise stock. Using questionnaires to fishermen, Lesage et al. (2003) determined a total of 2180 (95% CI 1012-3802) and 2478 (95% CI 1591-3464) harbor porpoises were taken in 2000 and 2001, respectively. The largest takes were in July and August around Miscou and the North Shore of the Gulf of St. Lawrence. According to the returned questionnaires, the fish species most usually associated with incidental takes of harbor porpoises include Atlantic cod, herring and mackerel. An at-sea observer program was also conducted during 2001 and 2002. However, due to low observer coverage that was not representative of the fishing effort, Lesage et al. (2003) concluded that resulting bycatch estimates were unreliable.

Table 2. From observer program data, summary of the incidental mortality of harbor porpoise (*Phocoena phocoena*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
U.S.								
Northeast Sink Gillnet	99-03	NA	Obs. Data, Weighout, Trip Logbook	.06, .06, .04, .02 .03	14[3],15[3], 4[3,8], 10[3], 12[3]	270[3], 507[3], 53[3,8], 444[3], 592[3]	.28, .37, .97, .37, .33	373 0.18
Mid-Atlantic Coastal Gillnet	99-03	NA	Obs. Data Weighout	.02, .02, .02, .01, .01	3, 1, 1,unk[9], 1	53, 21, 26, unk[9], 76	.49, .76, .95, .unk[9], 1.13	44[9] (0.61)
U.S. TOTAL	1999-2003							417 (0.17)
CANADA								
Groundfish Sink Gillnet	99-03	NA	Can. Trips	11, .41, .56, 0[10],0[10]	3, 5, 39, 0[10],0[10]	32, 28, 73, unk[10], unk[10]	NA	44 (NA)
Herring Weir	99-03	1998=255 licenses[5] 2002=22[6]	Coop. Data	NA	3, 0, 14, 3, 1	3, 0, 14, 3, 1	NA	4.2 (NA)
CANADIAN TOTAL	1999 - 2003							48 (NA)
GRAND TOTAL								465 (NA)

NA = Not available.

1. Observer data (Obs. Data) are used to measure bycatch rates; the U.S. data are collected by the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program, the Canadian data are collected by DFO. NEFSC collects Weighout (Weighout) landings data, that are used as a measure of total effort for the U.S. gillnet fisheries. The Canadian DFO catch and effort statistical system collected the total number of trips fished by the Canadians (Can. Trips), which was the measure of total effort for the Canadian groundfish gillnet fishery. Mandatory vessel trip report (VTR) (Trip Logbook) data are used to determine the spatial distribution of fishing effort in the Northeast sink gillnet fishery. Observed mortalities from herring weirs are collected by a cooperative program between fishermen and Canadian biologists (Coop. Data).
2. The observer coverage for the U.S. and Canadian sink gillnet fishery is measured in trips, and for the mid-Atlantic coastal gillnet fishery, the unit of effort is tons of fish landed.
3. Harbor porpoise taken before 1997 in observed pinger trips were added directly to the estimated total bycatch for that year. During 1997, harbor porpoises were taken on non-pingered scientific experimental strings within a time/area stratum that required pingers; during 1998, harbor porpoises were taken on a pingered string within a stratum that did not require pingers; during 2000, a harbor porpoise was taken on a non-pingered string within a stratum that did not require pingers but that stratum had other trips where strings with pingers were observed; and during 1999-2002, harbor porpoises were taken on pingered strings within strata that required pingers but that stratum also had observed strings without pingers. For estimates made during 1998 and after, a weighted bycatch rate was applied to effort from both pingered and non-pingered hauls within a stratum. The weighted bycatch rate was:

$$\sum_{i}^{ping\ non-ping} \frac{\#porpoise_i}{sslandings_i} \cdot \frac{\#hauls_i}{total\#hauls}$$

There were 10, 33, 44, 0, 11, 0, 2, 8, 6, 2 and 26 observed harbor porpoise takes on pinger trips from 1992 to 2002, respectively, that are included in the observed mortality column. In addition, there were 9, 0, 2, 1,1, 4, 0 and 1 observed harbor porpoise takes in 1995 to 2002, respectively, on trips dedicated to fish sampling versus dedicated to watching for marine mammals; these are included in the observed mortality column (Bisack 1997).

4 Only data after 1994 are reported because the observed coverages during 1993 and 1994 were negligible during the times of the year when harbor porpoise takes were possible.

5 There were 255 licenses for herring weirs in the Canadian Bay of Fundy region.

6 There were 22 active weirs around Grand Manan. The number of weirs elsewhere is unknown.

7 Sink gillnet vessels only. Number of drift gillnet vessels presently undetermined.

8 During 2001 in the U.S. Northeast sink gillnet fishery, there were 2 takes observed in the NEFSC observer program, this resulted in an estimate of 51 total bycaught harbor porpoises. In November 2001, there were two takes reported through the Marine Mammal Authorization Program that were from one sink gillnet haul that was located near Jeffery's Ledge. These two takes were then added to the 2 observed takes and 51 estimated total take derived from the observer data, resulting in 4 observed takes and 53 total takes for the fishery during 2001.

9 Sixty-five percent of sampling by the NEFSC fisheries observer program was concentrated in one area off the coast of Virginia. Coverage in other areas of the mid-Atlantic was <1%. Because of the low level of sampling that was not distributed proportionally throughout the mid-Atlantic region observed mortality is considered unknown in 2002. The four year average (1999-2001 and 2003) estimated mortality was applied as the best representative estimate.

10 The Canadian gillnet fishery was not observed during 2002 and 2003, but the fishery was active; thus, the bycatch estimate is unknown. The average bycatch for this fishery is from the three preceding years, 1999 to 2001.

Table 3. From strandings and entanglement data, summary of confirmed incidental mortality of harbor porpoises (*Phocoena phocoena*) by fishery: includes years sampled (Years), number of vessels active within the fishery (Vessels), type of data used (Data Type), mortalities assigned to this fishery (Assigned Mortality), and mean annual mortality.

Fishery	Years	Vessels	Data Type [1]	Assigned Mortality	Mean Annual Mortality
Unknown gillnet fishery	99-03	NA	Entanglement & Strandings	19, 1, 3, 2, 27	10.4
TOTAL					10.4

NA=Not Available.

[1] Data from records in the entanglement and strandings data base maintained by the New England Aquarium and the Northeast Regional Office/NMFS (Entanglement and Strandings).

Other Mortality

U.S.

There is evidence that harbor porpoises were harvested by natives in Maine and Canada before the 1960's, and the meat was used for human consumption, oil, and fish bait (NEFSC 1992). The extent of these past harvests is unknown, though it is believed to have been small. Up until the early 1980's, small kills by native hunters (Passamaquoddy Indians) were reported. In recent years it was believed to have nearly stopped (Polacheck 1989) until media reports in September 1997 depicted a Passamaquoddy tribe member dressing out a harbor porpoise. Further articles describing use of porpoise products for food and other purposes were timed to coincide with ongoing legal action in state court.

During 1993, 73 harbor porpoises were reported stranded on beaches from Maine to North Carolina (Smithsonian Marine Mammal Database). Sixty-three of those harbor porpoises were reported stranded in the U.S. mid-Atlantic region from New York to North Carolina between February and May. Many of the mid-Atlantic carcasses recovered in this area during this time period had cuts and body damage suggestive of net marking (Haley and Read 1993). Five out of 8 carcasses and 15 heads from the strandings that were examined showed signs of human interactions (net markings on skin and missing flippers or flukes). Decomposition of the remaining animals prevented determination of the cause of death. Earlier reports of harbor porpoise entangled in gillnets in Chesapeake Bay and along the New Jersey coast and reports of apparent mutilation of harbor porpoise carcasses raised concern that the 1993 strandings were related to a coastal net fishery, such as the American shad coastal gillnet fishery (Haley and Read 1993). Between 1994 and 1996, 107 harbor porpoise carcasses were recovered from beaches in Maryland, Virginia, and North Carolina and investigated by scientists. Only juvenile harbor porpoises were present in this sample. Of the 40 harbor porpoises for which cause of death could be established, 25 displayed definitive evidence of entanglement in fishing gear. In 4 cases it was possible to determine that the animal was entangled in monofilament nets (Cox et al. 1998).

Records of harbor porpoise strandings prior to 1997 are stored in the Smithsonian's Marine Mammal Database and records from 1997 to present are stored in the NE Regional Office/NMFS strandings and entanglement database. According to these records, the numbers of harbor porpoises that stranded on U.S. beaches from North Carolina to Maine during 1994 to 2003 were 106, 86, 94, 118, 59, 228, 27, 113, 79 and 122 respectively (Table 4). Of these, 3 stranded alive on a Massachusetts beach in 1996, were tagged, and subsequently released. In 1998, 2 porpoises that stranded on a New Jersey beach had tags on them indicating they were originally taken on an observed mid-Atlantic coastal gillnet vessel. During 1999, 6 animals stranded alive and were either tagged and released or brought to Mystic Aquarium for rehabilitation (Table 4).

During 1999, over half of the strandings occurred on beaches of Massachusetts and North Carolina. The states with the next largest numbers were Virginia, New Jersey and Maryland, in that order. The cause of death was investigated for all the 1999 strandings (Table 5). Of these, it was possible to determine that the cause of death of 38 animals was fishery interactions. Of these 38, 19 animals were in an area and time that were not part of a bycatch estimate derived using observer data. Thus, these 19 mortalities are attributed to an unknown gillnet fishery (Table 3). One additional animal was found mutilated (right flipper and fluke was cut off) and cause of death was attributed to an unknown human-caused mortality (Table 5).

During 2000, only 27 harbor porpoises stranded on beaches from Maine to North Carolina (Table 4). Of these, most came from Massachusetts (8) or North Carolina (6). The cause of death for 1 animal was in an area and time that was not part of a bycatch estimate derived from observer data, and thus was attributed to an unknown gillnet fishery (Tables 3 and 5). This animal was found on a beach in Virginia during May with mono-filament line wrapped around it. In addition, 1 animal was found mutilated and so cause of death was attributed to an unknown human-caused mortality (Table 5).

During 2001, 113 harbor porpoises were reported stranded, of these most came from Massachusetts (39), Virginia (28), and North Carolina (21). Thirteen of these strandings displayed signs of fishery interactions, and of these, 3 animals were in an area and time that were not part of a bycatch estimate derived from the observer data (Tables 3 and 5).

During 2002, 79 harbor porpoises were reported stranded, of which over half come from Massachusetts (42). Eleven animals displayed signs of emaciation and two signs of fishery interactions. Both of the strandings with fishery interactions were in the mid-Atlantic (Maryland and Virginia) during March.

During 2003, 122 harbor porpoises were reported stranded, of which approximately 1/3 came from Massachusetts (35) and an additional 1/3 came from North Carolina (39) (Table 4). The number of reported fishery interactions by state are: 3 in Maine, 2 in New Hampshire, 22 in Massachusetts, 1 in Rhode Island, 2 in New Jersey, 4 in Maryland, 16 in Virginia and 1 in North Carolina. Of these 51 strandings reported with fishery interactions, 27 were in an area and time that was not part of a bycatch estimate derived from the observer data (Tables 3 and 5).

Averaging 1999 to 2003, there was 1.4 animals per year that were stranded and mutilated and so cause of death was attributed to an unknown human-caused mortality (Table 5).

Stranding data probably underestimate the extent of fishery-related mortality and serious injury because all of the marine mammals which die or are seriously injured may not wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

Table 4. Summary of number of stranded harbor porpoises in the U.S. and Nova Scotia during January 1, 1999 to December 31, 2003, by year and area.

Area	Year					Total
	1999	2000	2001	2002	2003	
Maine[1]	3	2	4	8	5	22
New Hampshire	0	0	0	2	2	4
Massachusetts[2]	60	8	39	42	35	184
Rhode Island	3	0	1	1	2	7
Connecticut	0	0	0	1	0	1
New York[3]	10	2	7	6	8	33
New Jersey[4]	23	2	6	6	5	42
Delaware	9	1	3	3	1	17
Maryland	21	3	4	1	5	34
Virginia	40	3	28	6	19	96
North Carolina	59	6	21	3	39	128
Florida	0	0	0	0	1	1
TOTAL U.S.	228	27	113	79	122	569
Nova Scotia	1	3	2	5	3	14
GRAND TOTAL	229	30	115	84	125	583

1 In Maine, 1 animal stranded alive in March 2002, brought to Mystic Aquarium but died 2 days later.

2 In Massachusetts, during 1996 three animals stranded alive on a Massachusetts beach, were tagged and released alive. During 1999, five animals stranded alive and were tagged and released. During 2002, three animals stranded alive and were rehabilitated at Mystic Aquarium (1 in February, March and May).

3 In New York, one animal stranded alive in 1999, rehabilitated at Mystic Aquarium and died at the aquarium in April 2000.

4 In New Jersey, two porpoises that stranded in 1998 had been previously tagged and released from an observed mid-Atlantic coastal gill net fishing vessel.

Table 5. Cause of mortality of U.S. stranded harbor porpoises during January 1, 1999 to December 31, 2003. "Unique FI" is a fishery interaction that is in a time and area that could not be part of the mortality estimate derived from the observer program. "Not unique FI" is a fishery interaction that was in a time and area that may be part of the observer program derived mortality estimate. "No FI" is the cause of death was determined not to be related to a fishery interaction. "Alive" is stranded animal not dead. "CBD/Unk" is could not be determined or unknown cause of death.

Year	Unique FI[1]	Mutilation[2]	Not unique FI	No FI	Emaciated	CBD/Unk	Alive	Total
1999	19	1	19	41	30	112	6	228
2000	1	1	0	2	0	22	0	26
2001	3	1	10	32	0	64	3	113
2002	2	0	0	2	11	60	4	79
2003	27	4	24	37	3	25	2	122
Avg 99-03	10.4	1.4	10.6	22.8	8.8	56.6	3.0	113.6

[1] Attributed to an unknown fishery.
[2] Attributed to an unknown human-caused mortality.

CANADA

Whales and dolphins stranded between 1991 and 1996 on the coast of Nova Scotia were documented by the Nova Scotia Stranding Network (Hooker et al. 1997). Strandings on the beaches of Sable Island during 1970 to 1998 were documented by researchers with Dept. of Fisheries and Oceans, Canada (Lucas and Hooker 2000). Sable Island is approximately 170km southeast of mainland Nova Scotia. On the mainland of Nova Scotia, a total of 8 stranded harbor porpoises were recorded between 1991 and 1996: 1 in May 1991, 2 in 1993 (July and September), 1 in August 1994 (released alive), 1 in August 1994, and 3 in 1996 (March, April, and July (released alive)). On Sable Island, 8 stranded dead harbor porpoises were documented, most in January and February; 1 in May 1991, 1 in January 1992, 1 in January 1993, 3 in February 1997, 1 in May 1997, and 1 in June 1997. Two strandings during May-June 1997 were neonates (> 80 cm). The harbor porpoises that stranded in the winter (January-February) were on Sable Island, those in the spring (March to June) were in the Bay of Fundy (2 in Minas Basin and 1 near Yarmouth) and on Sable Island (2), and those in the summer (July to September) were scattered along the coast from the Bay of Fundy to Halifax.

Whales and dolphins stranded between 1997 and 2004 on the coast of Nova Scotia as recorded by the Marine Animal Response Society (MARS) and the Nova Scotia Stranding Network are as follows (Table 4): 3 harbor porpoises stranded in 1997 (1 in April, 1 in June and 1 in July), 2 stranded in June 1998, 1 in March 1999, 3 in 2000 (1 in February, 1 in June and 1 in August); 2 in 2001 (1 in July and 1 in December), 5 in 2002 (3 in July (1 released alive), 1 in August and 1 in September (released alive)), 3 in 2003 (2 in May (1 was released alive) and 1 in June (disentangled and released alive)) and 4 in 2004 (1 in April, 1 in May, 1 in July and 1 in November).

STATUS OF STOCK

The status of harbor porpoises, relative to OSP, in the U.S. Atlantic EEZ is unknown. On January 7, 1993, the National Marine Fisheries Service (NMFS) proposed listing the Gulf of Maine harbor porpoise as threatened under the Endangered Species Act (NMFS 1993). On January 5, 1999, NMFS determined the proposed listing was not warranted (NMFS 1999). On August 2, 2001, NMFS made available a review of the biological status of the Gulf of Maine/Bay of Fundy harbor porpoise population. The determination was made that listing under the Endangered Species Act (ESA) was not warranted and this stock was removed from the ESA candidate species list (NMFS 2001). There are insufficient data to determine population trends for this species. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because average annual fishery-related mortality and serious injury does not exceeded PBR.

REFERENCES

Barlow, J. and P. Boveng. 1991. Modeling age-specific mortality for marine mammal populations. *Mar. Mammal Sci.* 7:50-65.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S.Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K. D. 1997. Harbor porpoise bycatch estimates in the New England multispecies sink gillnet fishery: 1994 and 1995. *Rep. int Whal. Comm* 47: 705-14.

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise bycatch in the Gulf of Maine sink gillnet fishery, 1990-1993. *Rep. int Whal. Comm* 46:567-74.

Caswell, H., S. Brault, A. Read and T. Smith. 1998. Harbor porpoise and fisheries: an uncertainty analysis of incidental mortality. *Ecological Applications* 84(4):1226-1238.

Cox, T. M., A. J. Read, S. Barco, J. Evans, D. P. Gannon, H. N. Koopman, W.A. McLellan, K. Murray, J. Nicolas, D. A. Pabst, C. W. Potter, W. M. Swingle, V. G. Thayer, K. M. Touhey and A. J. Westgate. 1998. Documenting the bycatch of harbor porpoises, *Phocoena phocoena*, in coastal gill net fisheries from stranded carcasses. *Fish. Bull. U.S.* 96(4):727-734.

CUD [Conservation and Utilization Division]. 1994. Estimating harbor porpoise bycatch in the Gulf of Maine sink gillnet fishery. NOAA, NMFS, NEFSC Ref. Doc. 94-24. [Available from: NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543.]

DFO [Department of Fisheries and Oceans]. 1998. Harbour porpoise bycatch in the lower Bay of Fundy gillnet fishery. DFO Maritimes Regional Fisheries Status Report 98/7E. [Available from Department of Fisheries and Oceans, Resource management Branch, P.O. Box 550, Halifax, NS B3J 2S7, Canada.]

Gannon, D. P., J. E. Craddock and A. J. Read. 1998. Autumn food habits of harbor porpoises, *Phocoena phocoena*, in the Gulf of Maine. *Fish. Bull. U.S.* 96(3):428-437.

Gaskin, D. E. 1977. Harbour porpoise, *Phocoena phocoena* (L.), in the western approaches to the Bay of Fundy 1969-75. *Rep. int Whal. Comm* 27:487-492.

Gaskin, D. E. 1984. The harbor porpoise *Phocoena phocoena* (L.): Regional populations, status, and information on direct and indirect catches. *Rep. int Whal. Comm* 34:569-586.

Gaskin, D. E. 1992. The status of the harbour porpoise. *Can. Fld. Nat.* 106:36-54.

Gilbert, J. R. and K. M. Wynne. 1985. Harbor seal populations and fisheries interactions with marine mammals in New England, 1984. Fourth Annual Report, Contract NA-80-FA-C-00029, to NMFS, Northeast Fisheries Center, 166 Water St., Woods Hole, MA. 15 pp.

Gilbert, J. R. and K. M. Wynne. 1987. Harbor seal populations and fisheries interactions with marine mammals in New England. Final Report, Contract NA-EA-C-0070, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 15 pp.

Haley, N. J. and A. J. Read. 1993. Summary of the workshop on harbor porpoise mortalities and human interaction. NOAA Tech. Mem. NMFS-F/NER 5.

Hooker, S. K., R. W. Baird and M. A. Showell. 1997. Cetacean strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Meeting document SC/49/O5 submitted to the 1997 International Whaling Commission Scientific Committee meeting in Bournemouth, UK.

Johnston, D. W. 1995. Spatial and temporal differences in heavy metal concentrations in the tissues of harbour porpoises (*Phocoena phocoena* L.) from the western North Atlantic. M.S. Thesis, University of Guelph, Guelph, Ontario, Canada. 152 pp.

Kingsley, M. C. S. and R. R. Reeves. 1998. Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. *Can. J. Zool.* 76:1529-1550.

Koopman, H. N., A. J. Westgate and A. J. Read. 1999. Hematology values of wild harbor porpoise (*Phocoena phocoena*) from the Bay of Fundy Canada. *Mar. Mammal Sci.* 15(1):52-64.

Kraus, S. D. and S. Brault. 1997. A springtime field test of the use of pingers to reduce incidental mortality of harbor porpoises in gillnets. Meeting document SC/49/SM42 submitted to the 1997 International Whaling Commission Scientific Committee meeting in Bournemouth, UK.

Kraus, S. D., A. Read, E. Anderson, K. Baldwin, A. Solow, T. Sprawling and J. Williamson. 1997. Acoustic alarms reduce porpoise mortality. *Nature* 388:525.

Kraus, S. D., J. H. Prescott and G. S. Stone. 1983. Harbour porpoise, *Phocoena phocoena*, in the U.S. coastal waters of the Gulf of Maine: A survey to determine seasonal distribution and abundance. Report to the Director, National Marine Fisheries Service, 166 Water St., Woods Hole, MA. 15 pp.

Lamb, A. 2000. Patterns of harbor porpoise mortality in two US Atlantic sink gillnet fisheries and changes in life history parameters. Masters Thesis from Boston University.

Lesage, V., J. Keays, S. Turgeon and S. Hurtubise. 2003. Incidental mortality of harbour porpoises in the gillnet fishery of the Estuary and Gulf of St. Lawrence in 2000-2002. Canadian Science Advisory Secretariat. Research Document 2003/069. Available at http://www.dfo-mpo.gc.ca/csas/

Lucas, Z. N. and S. K. Hooker. 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. *Canadian Field-Naturalist* 114(1): 46-61.

Molyneaux, P. 2000. Tradition at stake. *National Fisherman* 80(11): 26-29.

Neimanis, A. S., A. J. Read, A. J. Westgate, H. N. Koopman, J. Y. Wang, L. D. Murison and D. E. Gaskin. 1995. Entrapment of harbour porpoises (*Phocoena phocoena*) in herring weirs in the Bay of Fundy, Canada. Working paper SC/47/SM18 for the International Whaling Commission, Dublin, Ireland.

NEFSC [Northeast Fisheries Science Center]. 1992. Harbor porpoise in eastern North America: Status and research needs. Results of a scientific workshop held May 5-8, 1992 at the Northeast Fisheries Science Center, Woods Hole, MA. NOAA, NMFS, NEFSC Ref. Doc. 92-06. [Available from: NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543.]

NMFS [National Marine Fisheries Service]. 2001. Status review of the Gulf of Maine/Bay of Fundy population of harbor porpoise under the Endangered Species Act (ESA). Federal Register 66(203): 53195-53197, October 19, 2001.

NMFS [National Marine Fisheries Service]. 1999. Listing of Gulf of Maine/Bay of Fundy population of harbor porpoise as threatened under the Endangered Species Act. Federal Register 64 (2): 465-471, January 05, 1999.

NMFS [National Marine Fisheries Service]. 1993. Proposed listing of Gulf of Maine population of harbor porpoises as threatened under the Endangered Species Act. Federal Register 58: 3108-3120, January 07, 1993.

Palka, D. 2000. Abundance of the Gulf of Maine/Bay of Fundy harbor porpoise based on shipboard and aerial surveys during 1999. NOAA-NMFS-NEFSC Ref. Doc. 00-07. 29 pp. [Available from: NMFS, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543.]

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA-NMFS-NEFSC Ref. Doc. 96-04; 37 pp. Available from: NMFS, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543.

Palka, D. 1995a. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50 *in*: A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int Whal. Commn* Special Issue 16.

Palka, D. 1995b. Influences on spatial patterns of Gulf of Maine harbor porpoises. pp. 69-75 *In:* A.S. Blix, L. Walløe and Ø. Ulltang (eds.) *Whales, seals, fish and man*. Elsevier Science B.V. The Netherlands.

Palka, D.L., A. J. Read, A. J. Westgate and D. W. Johnston. 1996. Summary of current knowledge of harbour porpoises in U.S. and Canadian Atlantic waters. *Rep. int Whal. Commn* 46:559-565.

Polacheck, T. 1989. Harbor porpoises and the gillnet fishery. *Oceanus* 32(1):63-70.

Polacheck, T., F. W. Wenzel and G. Early. 1995. What do stranding data say about harbor porpoises (*Phocoena phocoena*). Pp 169-180 *in:* A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int Whal. Commn* Special Issue 16.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int Whal. Commn* Special Issue 15: 133-147.

Read, A. J. and A. J. Westgate. 1997. Monitoring the movements of harbour porpoises (*Phocoena phocoena*) with satellite telemetry. *Marine Biology* 130:315-22.

Read, A. J., J. R. Nicolas and J. E. Craddock. 1996. Winter capture of a harbor porpoise in a pelagic drift net off North Carolina. *Fish. Bull. U.S.* 94:381-83.

Read, A. J. and A. A. Hohn. 1995. Life in the fast lane: The life history of harbour porpoises from the Gulf of Maine. *Mar. Mammal Sci.* 11(4)423-440.

Rosel, P. E., S. C. France, J. Y. Wang and T. D. Kocher. 1999a. Genetic structure of harbour porpoise *Phocoena phocoena* populations in the northwest Atlantic based on mitochondrial and nuclear markers. *Molecular Ecology* 8: S41-S54.

Rosel, P. E., R. Tiedemann and M. Walton. 1999b. Genetic evidence for limited trans-Atlantic movements of the harbor porpoise *Phocoena phocoena. Marine Biology* 133: 583-591.

Rossman, M.C. and R.L. Merrick. 1999. Harbor porpoise bycatch in the Northeast multispecies sink gillnet fishery and the mid-Atlantic coastal gillnet fishery in 1998 and during January-May 1999. NOAA-NMFS-NEFSC

Ref. Doc. 99-17, 36 p. [Available from: NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543.]

Smith, G. J. D., A. J. Read and D. E. Gaskin. 1983. Incidental catch of harbor porpoises, *Phocoena phocoena* (L.), in herring weirs in Charlotte County, New Brunswick, Canada. *Fish. Bull., U.S.* 81(3):660-2.

Trippel, E.A., and Shepherd, T.D. (in press). By-Catch of Harbour Porpoise (*Phocoena phocoena*) in the Lower Bay of Fundy Gillnet Fishery from 1998-2001. *DFO Res. Doc.* 2004/XXX.

Trippel, E. A., J. Y. Wang, M. B. Strong, L. S. Carter and J. D. Conway. 1996. Incidental mortality of harbour porpoise (*Phocoena phocoena*) by the gillnet fishery in the lower Bay of Fundy. *Can. J. Fish. Aquat. Sci.* 53:1294-1300.

Trippel, E. A., M. B. Strong, J. M. Terhune and J. D. Conway. 1999. Mitigation of harbour porpoise (*Phocoena phocoena*) bycatch in the gillnet fishery in the lower Bay of Fundy. *Can. J. Fish. Aquat. Sci.* 56:113-123.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Wang, J. Y., D. E. Gaskin and B. N. White. 1996. Mitochondrial DNA analysis of harbour porpoise, *Phocoena phocoena*, subpopulations in North American waters. *Can J Fish Aquat Sciences* 53:1632-45.

Westgate, A. J. and K. A. Tolley. 1999. Geographical differences in organochlorine contaminants in harbour porpoises *Phocoena phocoena* from the western North Atlantic. *Marine Ecology-Progress Series* 177:255-268.

Westgate, A. J., A. J. Read, T. M. Cox, T. D. Schofield, B. R. Whitaker and K. E. Anderson. 1998. Monitoring a rehabilitated harbor porpoise using satellite telemetry. *Mar. Mammal Sci.* 14(3):599-604.

Westgate, A. J., D. C. G. Muir, D. E. Gaskin and M. C. S. Kingsley. 1997. Concentrations and accumulation patterns of organochlorine contaminants in the blubber of harbour porpoises, *Phocoena phocoena*, from the coast of Newfoundland, the Gulf of St. Lawrence and the Bay of Fundy/Gulf of Maine. *Envir. Pollut* 95: 105-119.

Woodley, T. H. and A. J. Read. 1991. Potential rates of increase of a harbor porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. *Can. J. Fish. Aquat.* 48:2429-35.

November 2004

MESOPLODON BEAKED WHALES (*Mesoplodon* spp.): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Within the genus *Mesoplodon*, there are four species of beaked whales that reside in the northwest Atlantic. These include True's beaked whale, *Mesoplodon mirus*; Gervais' beaked whale, *M. europaeus*; Blainville's beaked whale, *M. densirostris*; and Sowerby's beaked whale, *M. bidens* (Mead 1989). These species are difficult to identify to the species level at sea; therefore, much of the available characterization for beaked whales is to genus level only. Stock structure for each species is unknown.

The distribution of *Mesoplodon* spp. in the northwest Atlantic is known principally from stranding records (Mead 1989; Nawojchik 1994; Mignucci-Giannoni *et al.* 1999). Off the U.S. Atlantic coast, beaked whale (*Mesoplodon* spp.) sightings have occurred principally along the shelf-edge and deeper oceanic waters (CETAP, 1982; Waring *et al.* 1992; Tove 1995; Waring *et al*. 2001; Palka *et al*. unpublished manuscript; Figure 1)). Most sightings were in late spring and summer, which corresponds to survey effort.

True's beaked whale is a temperate-water species that has been reported from Cape Breton Island, Nova Scotia, to the Bahamas (Leatherwood ~~etal.~~*et al.* 1976; Mead 1989). It is considered rare in Canadian waters (Houston 1990).

Gervais' beaked whales are believed to be principally oceanic, and strandings have been reported from Cape Cod Bay to Florida, into the Caribbean and the Gulf of Mexico (Leatherwood *et al.* 1976; Mead 1989; NMFS unpublished data). This is the most common species of *Mesoplodon* to strand along the U.S. Atlantic coast. The northernmost stranding was on Cape Cod.

Blainville's beaked whales have been reported from southwestern Nova Scotia to Florida, and are believed to be widely but sparsely distributed in tropical to warm-temperate waters (Leatherwood *et al.* 1976; Mead 1989, Nicolas *et al.* 1993). There are two records of strandings in Nova Scotia which probably represent strays from the Gulf Stream (Mead 1989). They are considered rare in Canadian waters (Houston 1990).

Sowerby's beaked whales have been reported from New England waters north to the ice pack, and individuals are seen along the Newfoundland coast in summer (Leatherwood *et al.* 1976; Mead 1989). Furthermore, a single stranding occurred off the Florida west coast (Mead 1989). This species is considered rare in Canadian waters (Lien *et al.* 1990).

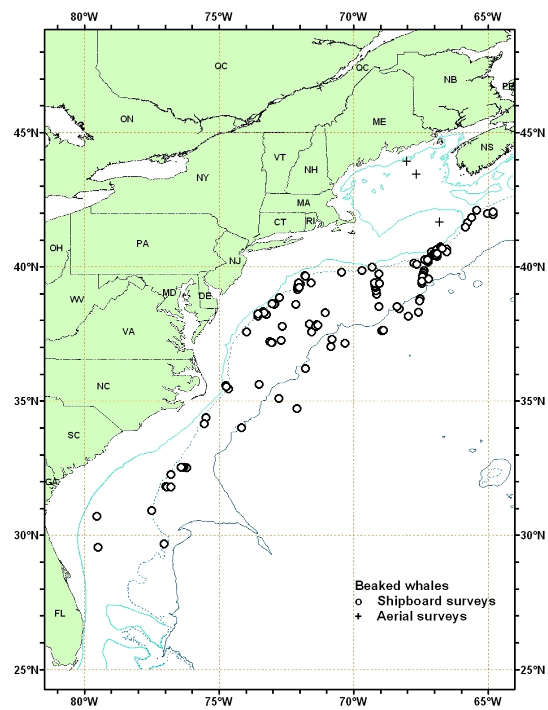

Figure 1. Distribution of beaked whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer 1998, 1999, and 2004. Isobaths are at 100 m, 1,000 m, and 4,000 m.

POPULATION SIZE

The total number of *Mesoplodon* spp. beaked whales off the eastern U.S. and Canadian Atlantic coast is unknown.

However, several estimates of the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 120 (CV=0.71) undifferentiated beaked whales was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 442 (CV=0.51) undifferentiated beaked whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Anon. 1990; Waring *et al.* 1992). An abundance of 262 (CV=0.99) undifferentiated beaked whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). An abundance of 370 (CV=0.65) and 612 (CV=0.73) undifferentiated beaked whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 330 (CV=0.66) undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for *g(0)* or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 99 (CV=0.64) undifferentiated beaked whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Table 1; Anon. 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for *g(0)* or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 1,519 (CV=0.69) undifferentiated beaked whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Palka *et al.* Unpubl. Ms.). Total track line length was 32,600km. The ships covered waters between the 50 and 1000 fathom isobaths, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom isobath, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom isobath. Data collection and analysis methods used were described in Palka (1995).

An abundance of 2,600 (CV=0.40) undifferentiated beaked whales was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* Unpubl. Ms.). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)*.

An abundance of 541 (CV=0.55) for undifferentiated beaked whales was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 4,163km of track line in waters south of Maryland (38°N) (Figure 1; Mullin and Fulling 2003). This estimate is a recalculation of the same data reported in previous SARs. For more details see Mullin and Fulling (2003). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993) where school size bias and ship attraction were accounted for.

The best 1998 abundance estimate for undifferentiated beaked whales is the sum of the estimates from the two U.S. Atlantic surveys, 3,141 (CV=0.34), where the estimate from the northern U.S. Atlantic is 2,600 (CV=0.40) and from the southern U.S. Atlantic is 541 (CV=0.55). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

An abundance of 2,167 (CV=0.587) for beaked whales was estimated from a line transect sighting survey conducted during June 12 to August 4, 2004 by a ship and plane that surveyed 10,761 km of track line in waters north of Maryland (about 38° N) to the Bay of Fundy (about 45° N) (Figure 1; Palka unpubl.). Shipboard data were collected using the two independent team line transect method and analyzed using the modified direct duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and g(0), the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line transect method (Hiby 1999) and analyzed accounting for g(0) and biases due to school size and other potential covariates (Figure 1; Palka unpubl.).

A shipboard survey of the U.S. Atlantic outer continental shelf and continental slope (water depths ≥ 50m) between Florida and Maryland (27.5 and 38ºN latitude) was conducted during June-August, 2004. The survey employed two independent visual teams searching with 50x bigeye binocluars. Survey effort was stratified to include increased effort along the continental shelf break and Gulf stream front in the mid-Atlantic. The survey included 5,659 km of trackline, and there were a total of 473 cetacean sightings. Sightings were most frequent in waters North of Cape Hatteras, North Carolina along the shelf break. Data were analyzed to correct for visibility bias (*g(0)*) and group-size bias employing line transect distance analysis and the direct duplicate estimator (Palka, 1995; Buckland *et al.*, 2001). The resulting abundance estimate for beaked whales between Florida and Maryland was 674 (CV =0.362).

The best 2004 abundance estimate for beaked whales is the sum of the estimates from the two 2004 U.S. Atlantic surveys, 2,841 (CV =0.456), where the estimate from the northern U.S. Atlantic is 2,167 (CV =0.587) , and from the southern U.S. Atlantic is 674 (CV =0.362). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Although the 1990-2004 surveys did not sample exactly the same areas or encompass the entire beaked whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective 1990-2004 data suggest that, seasonally, at least several thousand beaked whales are occupying these waters, with highest levels of abundance in the Georges Bank region. Recent results suggest that beaked whale abundance may be highest in association with Gulf Stream and warm-core ring features.

Because the estimates presented here were not dive-time corrected, they are likely negatively biased and probably underestimate actual abundance. Given that *Mesoplodon* spp. prefers deep-water habitats (Mead 1989) the bias may be substantial.

Table 1. Summary of abundance estimates for the undifferentiated complex of beaked whales which include *Ziphius* and *Mesoplodon* spp. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	2,600	0.40
Jul-Aug 1998	Florida to Maryland	541	0.55
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	3,141	0.34
Jun-Aug 2004	Maryland to the Bay of Fundy	2,167	0.59
Jun-Aug 2004	Florida to Maryland	674	0.36
Jun-Aug 2004	Bay of Fundy to Florida	2,841	0.46

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for undifferentiated beaked whales is 2,841 (CV =0.46). The minimum population estimate for the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 1,971. It is not possible to determine the minimum population estimate of only *Mesoplodon* beaked whales.

Current Population Trend

There are insufficient data to determine the population trends for these species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: length at birth is 2 to 3m, length at sexual maturity 6.1m for females, and 5.5m for males, maximum age for females were 30 growth layer groups (GLG's) and for males was 36 GLG's, which may be annual layers (Mead 1984).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the undifferentiated complex of beaked whales is 1,971. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for all species in the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 20. It is not possible to determine the PBR for only *Mesoplodon* beaked whales.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 1999-2003 total average estimated annual mortality of beaked whales in fisheries in the U.S. Atlantic EEZ was 1.0 and is derived from three components: 1) two stranded animals were entangled in fishing gear, 2) two animals were ship struck, and 3) one stranded animal died from acoustic or blunt trauma - see other mortality text and (Table 2).

Fishery Information

Total fishery-related mortality and serious injury cannot be estimated separately for each beaked whale species because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that any beaked whale stock which occurred in the U.S. Atlantic EEZ might have been subject to the observed fishery-related mortality and serious injury.

Bycatch has been observed by NMFS sea samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic trawl, Northeast sink gillnet, mid-Atlantic coastal gillnet, or North Atlantic bottom trawl fisheries by NMFS sea samplers. Detailed fishery information are reported in Appendix III.

Earlier Interactions

There is no historical information available that documents incidental mortality in either U.S. or Canadian Atlantic coast fisheries (Read 1994). The only documented bycatch of beaked whales is in the pelagic drift gillnet fishery (now prohibited). The bycatch only occurred from Georges Canyon to Hydrographer Canyon along the continental shelf break and continental slope during July to October (Northridge 1996). Forty-six fishery-related beaked whale mortalities were observed between 1989 and 1998. These included: 24 Sowerby's; 4 True's; 1 Cuvier's; and 17 undifferentiated beaked whales. Recent analysis of biological samples (genetics and morphological analysis) have been used to determine species identifications for some of the bycaught animals. Estimation of bycatch mortality by species are available for the 1994-1998 period. Prior estimates are for undifferentiated beaked whales. The estimated annual fishery-related mortality (CV in parentheses) was 60 in 1989 (0.21), 76 in 1990 (0.26), 13 in 1991 (0.21), 9.7 in 1992 (0.24) and 12 in 1993 (0.16). The 1994-1998 estimates by 'species' are:

Year	Cuvier's	Sowerby's	True's	*Mesoplodon* spp.
1994	1 (0.14)	3 (0.09)	0	0
1995	0	6 (0)	1 (0)	3 (0)
1996	0	9 (0.12)	2 (0.26)	2 (0.25)
1997	NA	NA	NA	NA
1998	0	2 (0)	2 (0)	7 (0)

During July 1996, one beaked whale was entangled and released alive with "gear in/around a single body part". Annual mortality estimates do not include any animals injured and released alive.

Other Mortality

From 1992-2000, a total of 53 beaked whales stranded along the U.S. Atlantic coast between Florida and

Massachusetts (NMFS unpublished data). This includes: 28 (includes one tentative identification) Gervais' beaked whales (one 1997 animal had plastics in esophagus and stomach, and Sargassum in esophagus; 2 animals that stranded in September 1998 in South Carolina showed signs of fishery interactions); 2 True's beaked whales; 5 Blainville's beaked whales; 1 Sowerby's beaked whale; 13 Cuvier's beaked whales (one 1996 animal had propeller marks, and one 2000 animal had a longline hook in the lower jaw) and 4 unidentified animals. One stranding of Sowerby's beaked whale was recorded on Sable Island between 1970-1998 (Lucas and Hooker 2000). The whale's body was marked by wounds made by the cookiecutter shark (*Isistius brasiliensis*), which has previously been observed on beaked whales (Lucas and Hooker 2000).

Also, several unusual mass strandings of beaked whales in North Atlantic marine environments have been associated with naval activities. During the mid- to late 1980's multiple mass strandings of Cuvier's beaked whales (4 to about 20 per event) and small numbers of Gervais' beaked whale and Blainville's beaked whale occurred in the Canary Islands (Simmonds and Lopez-Jurado 1991). Twelve Cuvier's beaked whales that live stranded and subsequently died in the Mediterranean Sea on 12-13 May 1996 was associated with low frequency acoustic sonar tests conducted by the North Atlantic Treaty Organization (Frantzis 1998). In March 2000, 14 beaked whales live stranded in the Bahamas; 6 beaked whales (5 Cuvier's and 1 Blainville's) died (Balcomb and Claridge 2001; Evans and England 2001; Cox *et al*., in review). Four Cuvier's, 2 Blainville's , and 2 unidentified beaked whales were returned to sea. The fate of the animals returned to sea is unknown, since none of the whales have been resighted. Necropsy of 6 dead beaked whales revealed evidence of tissue trauma associated with an acoustic or impulse injury that caused the animals to strand. Subsequently, the animals died due to extreme physiologic stress associated with the physical stranding (i.e., hyperthermia, high endogenous catecholamine release) (Anon. 2001).

During 2001-2003, twenty-four beaked whales stranded along the U.S. Atlantic coast (Table 2).

Table 2. Beaked whale (*Ziphius cavirostris* and *Mesoplodon* sp.) strandings along the U.S. Atlantic coast.

State	2001	2002	2003	Total
Maine	0	*M. mirus* (1)	*M. bidens* (1)[3]	2
Massachusetts	0	--	0	0
Virginia	0	*M. Europaeus* (2)[2]	*M. mirus* (1)[4]	3
North Carolina	*M. europaeus* (1) Mesoplodon sp. (3)	Unid. (1)	*M. europeaus* (2); *Mesoplodon* sp. (1)	9
South Carolina	*M. europaeus* (2)	*Ziphius* (1)	*Ziphius* (2)	5
Florida	*M. europaeus* (4[1])	--	*Ziphius* (1); *M. europaeus* (1)	5
Total	10	5	9	24[5]

[1] Acoustic or blunt trauma was the assigned cause of mortality for one animal stranded in Broward County in Sept.
[2] Ship strike was the likely cause of death for one animal
[3] Boat strike was the likely cause of death
[4] Entanglement in fishing gear was the likely cause of death
[5] The cause of death for most of the stranded animals could not be determined.

STATUS OF STOCK

The status of *Mesoplodon* beaked whales relative to OSP in U.S. Atlantic EEZ is unknown. These species are not listed as threatened or endangered under the Endangered Species Act. Although a species specific PBR cannot be determined, the permanent closure of the pelagic drift gillnet fishery has eliminated the principal known source of incidental fishery mortality. The total fishery mortality and serious injury for this group is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because of uncertainty regarding stock size and evidence of human induced mortality and serious injury associated with acoustic activities.

REFERENCES

Anon. 1990. Cruise results, NOAA Ship CHAPMAN, Cruise No. 90-05. Marine Mammal Sighting Survey. 5 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA-NMFS- SEFSC and NEFSC. 4 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. 5 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1994. Cruise results, NOAA ship RELENTLESS, Cruise No. RS 9402, Marine Mammal Survey/Warm Core Ring Study. 8 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Balcomb, K. C. III and D. E. Claridge. 2001. A mass stranding of cetaceans caused by naval sonar in the Bahamas. *Bahamas J. Sci*. 2:2-12.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Andersen, K. P. Burnham and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 446 pp.

Buckland, S. T., D.R. Andersen, K.P Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling estimating abundance of biological populations. *Oxford University Press*, New York, 432 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Cox, T.M., T. Ragen, A.J. Read, E. Vos, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernadez, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P.D. Jepson, D. Ketten, C.D. MacLeod, P. Miller, S. Moore, D. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead, L. Benner. 2004. Report of a workshop to understand the impacts of anthropogenic sound on beaked whales. 33 pp. Submitted to J. Cetacean Res. Manage.

Frantzis, A. 1998. Does acoustic testing strand whales? *Nature* 392:29.

Evans, D.L. and G. R. England. 2001. Joint interim report - Bahamas Marine Mammal Stranding - event of 15-16 March 2000. U.S. Department of Commerce; Secretary of the Navy, vi + 59 pp. Available at: http://www.nmfs.noaa.gov/pr/acoustics/acoustics_reports.htm.

Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 *in*: Garner *et al.* (eds). Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.

Houston, J. 1990. Status of Blainville's beaked whale, *Mesoplodon densirostris*, in Canada. *Can. Field Nat.* 104(1): 117-120.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lien J., F. Barry, K. Breeck, and U. Zuschlag. 1990. Status of Sowerby's Beaked Whale, *Mesoplodon bidens*, in Canada. *Can. Field Nat.* 104(1): 125-130.

Lucas, Z. N. and S. K. Hooker. 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. *Can. Field Nat.*:114 (45-61).

Mead, J. G. 1984. Survey of reproductive data for the beaked whales (*Ziphiidae*). *Rep. int Whal. Commn*. Special Issue 6:91-96.

Mead, J. G. 1989. Beaked whales of the genus *Mesoplodon*. Pages 349-430 *in:* S. H., Ridgway and R. Harrison (eds), Handbook of marine mammals, Vol. 4: River Dolphins and toothed whales. *Academic press*, San Diego, 442 pp.

Mignucci-Giannoni, A. A., B. Pinto-Rodríguez, M. Velasco-Escudero, R. A. Montoya-Ospina, N. M. Jiménez, M.A. Rodríguez-López, E. H. Williams, Jr., and D. K. Odell. 1999. Cetacean strandings in Puerto Rico and the Virgin Islands. *J. Cetacean Res. Manage*. 1:191-198.

Mullin, K. D. and G. L. Fulling. 2003. Abundance of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. *Fish. Bull., U.S.*101:603-613.

Nawojchik, R. 1994. First record of *Mesoplodon densirostris* (Cetacea: Ziphiidae) from Rhode Island. *Mar. Mammal. Sci.* 10: 477-480.

Nicolas, J., A. Williams and G. Repucci. 1993. Observations of beaked whales (*Mesoplodon* spp.) in the western North Atlantic Ocean. Proceedings of the Tenth Biennial Conference on the Biology of Marine Mammals, Nov. 11-15, 1993, Galveston, TX (Abstract).

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. *Rep. int Whal. Commn*. (Special Issue 16):27-50.

Palka, D. and Hammond, P.S. 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci. 58: 777-787.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the Northwest Atlantic. *Rep. int Whal. Commn.* (Special Issue 1): 133-147.

Simmonds, M. P. and L. F. Lopez-Jurado. 1991. Whales and the military. *Nature* 351:448.

Trove, M. 1995. Live sighting of *Mesoplodon* CF. *M. Mirus*, True's Beaked Whale. *Mar. Mammal Sci.* 11(1): 80-85.

Wade, P. R., and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES C.M.* 1992/N:12. 29 pp.

Waring, G. T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Waring, G.T., T. Hamazaki, D. Sheehan, G. Wood, and S. Baker. 2001. Characterization of beaked whale (Ziphiidae) and sperm whale (*Physeter macrocephalus*) summer habitat in shelf-edge and deeper waters off the northeast U.S. *Mar. Mammal Sci.* 17(4): 703-717.

November 2004

RISSO'S DOLPHIN (*Grampus griseus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Risso's dolphins are distributed worldwide in tropical and temperate seas. They generally have an oceanic range, and occur along the Atlantic coast of North America from Florida to eastern Newfoundland (Leatherwood *et al.* 1976; Baird and Stacey 1990). Off the northeast U.S. coast, Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank during the spring, summer, and autumn (CETAP 1982; Payne *et al.* 1984). In winter, the range begins at the mid-Atlantic bight and extends further into oceanic waters (Payne *et al.* 1984). In general, the population occupies the mid-Atlantic continental shelf edge year round, and is rarely seen in the Gulf of Maine (Payne *et al.* 1984). During 1990, 1991 and 1993, spring/summer surveys conducted in continental shelf edge and deeper oceanic waters had sightings of Risso's dolphins associated with strong bathymetric features, Gulf Stream warm-core rings, and the Gulf Stream north wall (Waring *et al.* 1992; Waring 1993). There is no information on stock differentiation of Risso's dolphin in the western North Atlantic.

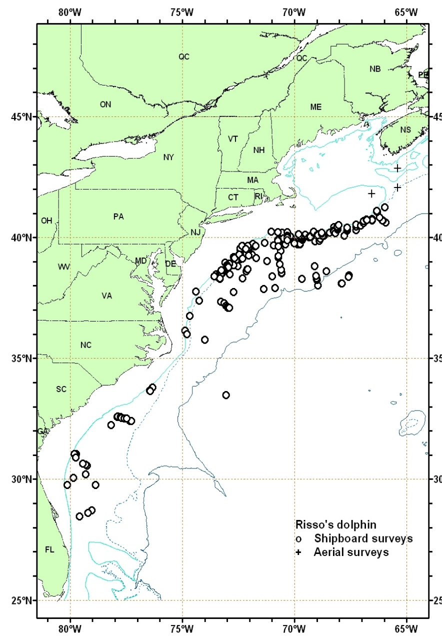

Figure 1. Distribution of Risso's dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1998, 1999, and 2004. Isobaths are 100 m, 1,000 m, and 4,000 m.

POPULATION SIZE

Total numbers of Risso's dolphins off the U.S. or Canadian Atlantic coast are unknown, although eight estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 4,980 Risso's dolphins (CV=0.34) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 11,017 (CV=0.58) Risso's dolphins was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). An abundance of 6,496 (CV=0.74) and 16,818 (CV=0.52) Risso's dolphins was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 212 (CV=0.62) Risso's dolphins was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for *g(0)* or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 5,587 (CV=1.16) Risso's dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* Unpub. Ms.). Total track line length was 32,600km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 18,631 (CV=0.35) Risso's dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* Unpub. Ms.). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)*.

An abundance of 10,479 (CV=0.51) Risso's dolphins was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 5,570km of track line in waters south of Maryland (38°N) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for Risso's dolphins, 29,110 (CV=0.29), is the sum of the estimates from the two 1998 U.S. Atlantic surveys where the estimate from the northern U.S. Atlantic is 18,631 (CV=0.35) and from the southern U.S. Atlantic is 10,479 (CV=0.51). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

An abundance of 22,389 (CV=0.823) for Risso's dolphins was estimated from a line transect sighting survey conducted during June 12 to August 4, 2004 by a ship and plane that surveyed 10,761 km of track line in waters north of north of Maryland (about $38N^0$) to the Bay of Fundy (about $45N^0$) (Figure 1; Palka Unpub. Ms.). Shipboard data were collected using the two independent team line transect method and analyzed using the modified direct duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and *g(0)*, the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line transect method (Hiby 1999) and analyzed accounting for *g(0)* and biases due to school size and other potential covariates (Figure 1; Palka Unpub. Ms.).

A survey of the U.S. Atlantic outer continental shelf and continental slope (water depths ≥ 50m) between Florida and Maryland (27.5 and 38 ºN latitude) was conducted during June-August, 2004. The survey employed two independent visual teams searching with 50x bigeye binocluars. Survey effort was stratified to include increased effort along the continental shelf break and Gulf stream front in the mid-Atlantic. The survey included 5,659 km of trackline, and there were a total of 473 cetacean sightings. Sightings were most frequent in waters North of Cape Hatteras, North Carolina along the shelf break. Data were analyzed to correct for visibility bias (*g(0)*) and group-size bias employing line transect distance analysis and the direct duplicate estimator (Palka, 1995; Buckland *et al.*, 2001). The resulting abundance estimate for Risso's dolphins between Florida and Maryland was 5,426 (CV =0.540).

The best 2004 abundance estimate for Risso's dolphins is the sum of the estimates from the two 2004 U.S. Atlantic surveys, 27,815 (CV =0.671), where the estimate from the northern U.S. Atlantic is 22,389 (CV =0.823) , and from the southern U.S. Atlantic is 5,426 (CV =0.540). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Table 1. Summary of abundance estimates for the western North Atlantic Risso's dolphin. Month, year, and area covered during each abundance survey, resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	18,631	0.35
Jul-Aug 1998	Florida to Maryland	10,479	0.51
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	29,110	0.29
Jun-Aug 2004	Maryland to Bay of Fundy	22,389	0.82
Jun-Aug 2004	Florida to Maryland	5,426	0.54
Jun-Aug 2004	Bay of Fundy to Florida	27,815	0.67

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for Risso's dolphins is 27,815 (CV=0.67). The minimum population estimate for the western North Atlantic Risso's dolphin is 16,645.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 16,645. The maximum productivity rate is 0.04 , the default value for cetaceans (Barlow *et al.* 1995). The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.48 because the CV of the average mortality estimate is between 0.3 and 0.6 (Wade and Angliss 1997). PBR for the western North Atlantic Risso's dolphin is 160.

ANNUAL HUMAN-CAUSED MORTALITY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1999-2003 was 51 Risso's dolphins (CV= 0.34); Table 2).

Fishery Information

Detailed fishery information is reported in Appendix III.

Earlier Interactions

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the U.S. With implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in that year, an observer program was established which has recorded fishery data and information of incidental bycatch of marine mammals. DWF effort in the U.S. Atlantic Exclusive Economic Zone (EEZ) under MFCMA has been directed primarily towards Atlantic mackerel and squid.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC)

Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, pelagic pair trawl fishery, and pelagic longline fishery, but no mortalities or serious injuries have been documented in the Northeast sink gillnet, mid-Atlantic coastal gillnet, or North Atlantic bottom trawl observed fisheries.

Pelagic Longline

Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 10,311 sets in 1992, 10,444 sets in 1993, 11,082 sets in 1994, 11,493 sets in 1995, 9,864 sets in 1996, 9,499 sets in 1997, 7,589 sets in 1998, 6,786 sets in 1999 and 6,582 sets in 2000 (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999; Yeung 1999a; Yeung *et al.* 2000; Yeung 2001). This annual effort has been recalculated to include those sets targeting other species in conjunction with tuna/swordfish, instead of just effort that exclusively targeted tuna/swordfish as in previous reports (Johnson *et al.* 1999; Yeung 1999a). The result is an average increase in self-reported effort of roughly 10% on the average (Yeung *et al.* 2000). The fishery has been observed from January to March off Cape Hatteras, in May and June in the entire mid-Atlantic, and in July through December in the mid-Atlantic Bight and off Nova Scotia. This fishery has been monitored with 3-6% observer coverage, in terms of sets observed, since 1992. The 1993-1997 estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replaces previous estimates for the 1990-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999). Further, Yeung (1999b), revised the 1992-1997 fishery mortality estimates in Johnson *et al.* (1999) to include seriously injured animals. The 1998, 1999 and 2000 bycatch estimates were from Yeung (1999a), Yeung *et al.* (2000) and Yeung (2001), respectively. Most of the estimated marine mammal bycatch was from U.S. Atlantic EEZ waters between South Carolina and Cape Cod. Excluding the Gulf of Mexico, from 1992-2000 one mortality was observed in both 1994 and 2000, and 0 in other years. The observed number of seriously-injured but released alive individuals from 1992-2000 was, respectively, 2, 0, 6, 4, 1, 0, 1, 1 and 1 (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999; Yeung 1999a; Yeung *et al.* 2000; Yeung 2001)) (Table 2). Estimated annual fishery-related mortality (CV in parentheses) was 17 in 1994 (1.0), 41 in 2000 (1.0), 24 in 2001, 20 in 2002, and 0 in 2003 (Table 2). Seriously injured and released alive animals were estimated to be 54 (0.7) in 1992, 0 in 1993, 120 (0.57) in 1994, 103 (0.68) in 1995, 99 (1.0) in 1996, 0 in 1997, 57 (1.0) in 1998, 22 (1.0) in 1999, 23 (1.0) in 2000, 45 in 2001, 8 in 2002, and 40 in 2003 (Table 2). The average combined mortality for 1999-2003 is 45 Risso’s dolphins (CV =0.38; Table2).

Northeast Sink Gillnet

Estimated annual mortalities (CV in parentheses) from this fishery are: 0 in 1999, 15 (1.06) in 2000, and 0 in 2001-2003 (Table 2). The 1999-2003 average mortality in this fishery is 3 Risso’s dolphins (CV =1.06).

Table 2. Summary of the incidental mortality of Risso's dolphin (*Grampus griseus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the observed mortalities and serious injuries recorded by on-board observers , the estimated annual mortality and serious injury, the combined annual estimates of mortality and serious injury (Estimated Combined Mortality), the estimated CV of the combined estimates (Estimated CVs) and the mean of the combined estimates (CV in parentheses).

Fishery	Years	Vessels[3]	Data Type[1]	Observer Coverage	Observed Serious Injury	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Estimated Combined Mortality	Estimated CVs	Mean Annual Mortality
Pelagic Longline[2] (excluding NED-E)[4]	99-03	205, 193, 70, 54, 21	Obs. Data Logbook	.04, .04, .02, .04, .02	1, 1, 2, 1, 3	0, 0, 1, 1, 0, 0	22, 23, 45, 8, 40	0, 41, 24, 20, 0	22, 64, 69, 28, 40	1.0, 1.0, 0.57, 0.68, 0.63	45 (0.38)
Pelagic Longline - NED-E area only [4]	2001-2003	180, 482, 535 sets	Obs. Data Logbook	1, 1, 1	4, 3, 0	0,0,1	4, 3, 0	0,0,1	4, 3, 1	0, 0, 0	3 (0)
Northeast Sink Gillnet	99-03	1993=349 1998=301	Obs. Data Weighout Trip Logbook	.06, .06, .04, .02, .03	0,0,0, 0,0	0, 1, 0, 0, 0	0,0,0, 0,0	0, 15, 0, 0, 0	0, 15, 0, 0, 0	0, 1.06, 0, 0, 0	3 (1.06)
TOTAL											51 (0.34)

1 Observer data (Obs. Data) are used to measure bycatch rates and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects landings data (Weighout), and total landings are used as a measure of total effort for the coastal gillnet fishery.

2 1996-1999 mortality estimates were taken from Table 9 in Yeung *et al.* (NMFS Miami Laboratory PRD 99/00-13), and exclude the Gulf of Mexico. 2000 mortality estimates were taken from Table 10 in Yeung (2001).

3 Number of vessels in the fishery are based on vessels reporting effort to the pelagic longline logbook.

4 An experimental program to test effects of gear characteristics, environmental factors, and fishing practices on marine turtle bycatch rates in the Northeast Distant (NED-E) water component of the fishery was conducted from June 1, 2001-December 31, 2003. Observer coverage was 100% during this experimental fishery. Summaries are provided for the pelagic longline EXCLUDING the NED-E area in one row and for ONLY the NED in the second row. (Garrison, 2003; Garrison and Richards, 2004).

Other mortality

From 1999-2003, twenty Risso's dolphin strandings were recorded along the U.S. Atlantic coast (NMFS unpublished data). In eastern Canada, one Risso's dolphin stranding was reported on Sable Island, Nova Scotia from 1970-1998 (Lucas and Hooker 2000).

Risso's dolphin	1999	2000	2001	2002	2003
Maine					
New Hampshire					
Massachusetts			1*	5	
Rhode Island					
Connecticut					
New York				1	
New Jersey		1			
Delaware					
Maryland			1	1	
Virginia			1		
North Carolina	1		3	2	1
South Carolina					
Georgia					
Florida			1	1	1
TOTAL	1	1	6	10	2

*Mass. 2001 - had signs of Fishery Interaction

STATUS OF STOCK

The status of Risso's dolphins relative to OSP in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. The total fishery mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, can not be considered to be insignificant and approaching a zero mortality and serious injury rate. The 1999-2003 average annual fishery-related mortality does not exceed PBR; therefore, this is not a strategic stock.

REFERENCES

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA-NMFS-SEFSC and NEFSC, 4 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. 5 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Anon. 1994. Cruise results, NOAA ship RELENTLESS, Cruise No. RS 9402, Marine Mammal Survey/Warm Core Ring Study. 8 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Baird, R. W. and P. J. Stacey. 1990. Status of Risso's dolphin, *Grampus griseus*, in Canada. *Can. Field Nat.* 105:233-242.

Buckland, S. T., D. R. Anderson, K. P. Burnham and S. L. Laake. 1993. Distance sampling: estimating abundance of biological populations. *Chapman and Hall*, New York, NY, 446 pp.

Buckland, S. T., D.R. Andersen, K.P Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling estimating abundance of biological populations. *Oxford University Press*, New York, 432 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Cramer J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp. NMFS, Southeast Fisheries Science Center, Miami, FL.

Gerrior, P., A. S. Williams and D. J. Christensen. 1994. Observations of the 1992 U.S. pelagic pair trawl fishery in the Northwest Atlantic. *U.S. Mar. Fish. Rev.* 56(3): 24-27.

Goudey, C. A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic. Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 10 pp.

Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 *in*: Garner *et al.* (eds). Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.

Goudey, C. A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic. Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 13 pp.

Johnson, D. R., C. A. Brown and C. Yeung. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. NOAA Tech. Memo. NMFS-SEFSC-418, 70 pp. NMFS, Southeast Fisheries Science Center, Miami, FL.

Laake, J. L., S. T. Buckland, D. R. Anderson and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado. 72 pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lucas, Z. N. and S. K. Hooker. 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. *Can. Field Nat.*:114 (45-61).

Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. *Fish. Bull., U.S.*

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500160.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Biology of the Phocoenids. *Rep. int Whal. Commn*. (Special Issue 16):27-50.

Palka, D. and Hammond, P.S. 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci. 58: 777-787.

Palka, D., G. Waring, and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. *Fish. Bull., U.S.*

Payne, P. M., L. A. Selzer and A. R. Knowlton. 1984. Distribution and density of cetaceans, marine turtles, and seabirds in the shelf waters of the northeastern United States, June 1980-December 1983, based on shipboard observations. 245 p. NOAA/NMFS Contract No. NA-81-FA-C-00023.

Scott, G. P. and C. A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1994-1995. Miami Laboratory Contribution MIA-96/97-28

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S.,* 88:347-360.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES Marine Mammals Comm.* CM 1992/N:12, 29 pp.

Waring, G. T. 1993. Spatial patterns of six cetaceans along a linear habitat. Proceedings of the Tenth Biennial Conference on the Biology of Marine Mammals, Nov. 11-15, 1993, Galveston, TX (Abstract)

Waring, G.T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA-NMFS-NEFSC, Lab. Ref. Doc. No. 98-09, 21 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Waring, G. T., D. L. Palka, P. J. Clapham, S. Swartz, M. C. Rossman, T. V. N. Cole, L. J. Hansen, K. D. Bisack, K. D. Mullin, R. S. Wells, D. K. Odell, and N. B. Barros. 1999. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments — 1999. U.S. Dep. Commer., NOAA Tech. Memo NMFS-NE-153, 196pp.

Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Tech. Memo. NMFS-SEFSC-430, 26 pp. NMFS, Southeast Fisheries Science Center, Miami, FL.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Tech. Memo. NMFS-SEFSC-429, 23 pp. NMFS, Southeast Fisheries Science Center, Miami, FL.

Yeung, C., S. Epperly, and C. A. Brown. 2000. Preliminary revised estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet, 1992-1999. NMFS, Miami Lab. PRD Contribution Number 99/00-13. 58 pp.

Yeung, C. 2001. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1999-2000. NOAA Tech. Memo. NMFS-SEFSC-467, 43 p. NMFS, Southeast Fisheries Science Center, Miami, FL.

STRIPED DOLPHIN (*Stenella coeruleoalba*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The striped dolphin, *Stenella coeruleoalba*, is distributed worldwide in warm-temperate to tropical seas (Archer and Perrin 1997). Striped dolphins are found in the western North Atlantic from Nova Scotia south to at least Jamaica and in the Gulf of Mexico. In general, striped dolphins appear to prefer continental slope waters offshore to the Gulf Stream (Leatherwood *et al.* 1976; Perrin *et al.* 1994; Schmidly 1981). There is very little information concerning striped dolphin stock structure in the western North Atlantic (Archer and Perrin 1997).

In waters off the northeastern U.S. coast, striped dolphins are distributed along the continental shelf edge from Cape Hatteras to the southern margin of Georges Bank, and also occur offshore over the continental slope and rise in the mid-Atlantic region (CETAP 1982; Mullin and Fulling 2003; Palka *et al.* Unpub. Ms.; Figure 1). Continental shelf edge sightings in this program were generally centered along the 1,000m depth contour in all seasons (CETAP 1982). During 1990 and 1991 cetacean habitat-use surveys, striped dolphins were associated with the Gulf Stream north wall and warm-core ring features (Waring *et al.* 1992). Striped dolphins seen in a survey of the New England Sea Mounts (Palka 1997) were in waters that were between 20^0 and 27^0C and deeper than 900m.

Although striped dolphins are considered to be uncommon in Canadian Atlantic waters (Baird *et al.* 1997), recent summer sightings (2-125 individuals) in the deeper and warmer waters of the Gully (submarine canyon off eastern Nova Scotia shelf) suggest that this region may be an important part of their range (Gowans and Whitehead 1995; Baird *et al.* 1997).

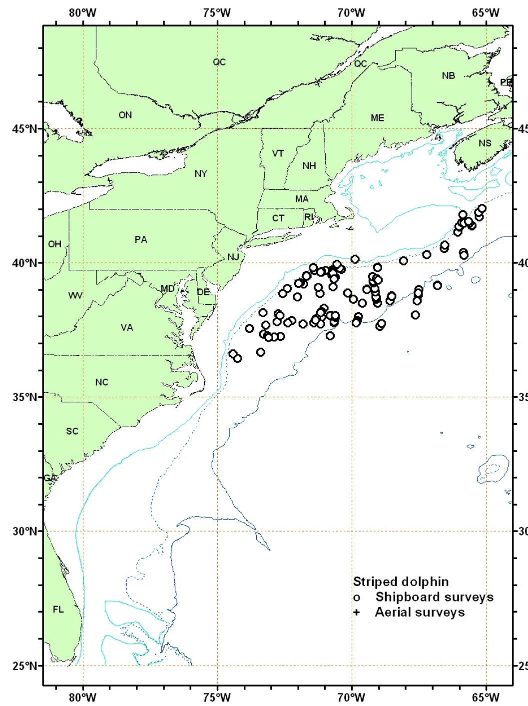

Figure 1. Distribution of striped dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer 1998, 1999, and 2004. Isobaths are at 100 m, 1,000 m, and 4,000 m.

POPULATION SIZE

Total numbers of striped dolphins off the U.S. or Canadian Atlantic coast are unknown, although several estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas west of Georges Bank (Figure 1). An abundance of 36,780 striped dolphins (CV=0.27) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental, shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 25,939 (CV=0.36) and 13,157 (CV=0.45) striped dolphins was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates

An abundance of 31,669 (CV=0.73) striped dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St.

Lawrence (Palka *et al.* Unpubl. Ms.). Total track line length was 32,600km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 39,720 (CV=0.45) for striped dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* Unpubl. Ms.). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)*.

An abundance of 10,225 (CV=0.91) for striped dolphins was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 4,163km of track line in waters south of Maryland (38°N) (Figure 1; Mullin and Fulling 2003). This estimate is a recalculation of the same data reported in previous SARs. For more details see Mullin and Fulling (2003). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993) where school size bias and ship attraction were accounted for.

The best 1998 abundance estimate for striped dolphins is the sum of the estimates from the two U.S. Atlantic surveys, 49,945 (CV=0.40), where the estimate from the northern U.S. Atlantic is 39,720 (CV=0.45) and from the southern U.S. Atlantic is 10,225 (CV=0.91). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

An abundance of 44,219 (CV=0.523) for striped dolphins was estimated from a line transect sighting survey conducted during June 12 to August 4, 2004 by a ship and plane that surveyed 10,761 km of track line in waters north of Maryland (about 38° N) to the Bay of Fundy (about 45° N) (Figure 1; Palka unpubl.). Shipboard data were collected using the two independent team line transect method and analyzed using the modified direct duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and g(0), the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line transect method (Hiby 1999) and analyzed accounting for g(0) and biases due to school size and other potential covariates (Figure 1; Palka unpubl.).

A shipboard survey of the U.S. Atlantic outer continental shelf and continental slope (water depths ≥ 50m) between Florida and Maryland (27.5 and 38ºN latitude) was conducted during June-August, 2004. The survey employed two independent visual teams searching with 50x bigeye binocluars. Survey effort was stratified to include increased effort along the continental shelf break and Gulf stream front in the mid-Atlantic. The survey included 5,659 km of trackline, and there were a total of 473 cetacean sightings. Sightings were most frequent in waters North of Cape Hatteras, North Carolina along the shelf break. Data were analyzed to correct for visibility bias (*g(0)*) and group-size bias employing line transect distance analysis and the direct duplicate estimator (Palka, 1995; Buckland *et al.*, 2001). The resulting abundance estimate for striped dolphins between Florida and Maryland was 42,407 (CV =0.534).

The best 2004 abundance estimate for striped dolphins is the sum of the estimates from the two 2004 U.S. Atlantic surveys, 86,626 (CV =0.374), where the estimate from the northern U.S. Atlantic is 44,219 (CV =0.523) , and from the southern U.S. Atlantic is 42,407 (CV =0.534). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Table 1. Summary of abundance estimates for western North Atlantic striped dolphins. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	39,720	0.45
Jul-Aug 1998	Florida to Maryland	10,225	0.91
Jul-Sep 1998	Florida to Gulf of St. Lawrence (combined)	49,945	0.40
Jun-Aug 2004	Maryland to the Bay of Fundy	44,219	0.52
Jun-Aug 2004	Florida to Maryland	42,407	0.53
Jun-Aug 2004	Bay of Fundy to Florida	86,626	0.37

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for striped dolphins is 86,626 (CV=0.37). The minimum population estimate for the western North Atlantic striped dolphin is 63,909.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 63,909. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is 0.5 because this stock is of unknown status. PBR for the western North Atlantic striped dolphin is 639.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality to this stock during 1999-2003 was zero striped dolphins.

Fishery Information

Detailed fishery information are reported in Appendix III.

Earlier Interactions

The pelagic drift gillnet fishery is now closed. Forty striped dolphin mortalities were observed between 1989 and 1998 and occurred east of Cape Hatteras in January and February, and along the southern margin of Georges Bank in summer and autumn (Northridge 1996). Estimated annual mortality and serious injury (CV in parentheses) attributable to the pelagic drift gillnet fishery were 39 striped dolphins in 1989 (0.31), 57 in 1990 (0.33), 11 in 1991 (0.28), 7.7 in 1992 (0.31), 21 in 1993 (0.11), 13 in 1994 (0.06), 2 in 1995 (0), 7 in 1996

(CV=0.22), no fishery in 1997 and 4 in 1998 (CV=0).

In the North Atlantic bottom trawl fishery the only reported fishery-related mortalities (two) occurred in 1991, where the total estimated mortality and serious injury attributable to this fishery for 1991 was 181 (CV=0.97).

USA

Bycatch has previously been observed by NMFS Sea Samplers in the pelagic drift gillnet and North Atlantic bottom trawl fisheries (see above) but no mortalities or serious injuries have recently been documented in any U.S. fishery.

CANADA

No mortalities were documented in review of Canadian gillnet and trap fisheries (Read 1994). However, in a recent review of striped dolphins in Atlantic Canada two records of incidental mortality have been reported (Baird *et al.* 1997) In the late 1960's and early 1970's two mortalities each, were reported in trawl and salmon net fisheries.

Between January 1993 and December 1994, 36 Spanish deep-water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211sets), were observed in NAFO Fishing Area 3 (off the Grand Bank) (Lens 1997). A total of 47 incidental catches were recorded, which included two striped dolphins. The incidental mortality rate for striped dolphins was 0.014/set.

Other Mortality

From 1995-1998, 7 striped dolphins were stranded between Massachusetts and Florida (NMFS unpublished data). From 1999-2003, forty-three dolphins were reported stranded from Maine to Florida (NMFS unpublished data). There were no signs of human interactions or mass strandings. The number of reported strandings per year were 2003 (19), 2002 (5), 2001 (9), 2000 (5), and 1999 (5).

In eastern Canada, 10 strandings were reported off eastern Canada from 1926-1971, and 19 from 1991-1996 (Sergeant *et al.* 1970; Baird *et al.* 1997; Lucas and Hooker 1997). In both time periods, most of the strandings were on Sable Island, Nova Scotia.

STATUS OF STOCK

The status of striped dolphins, relative to OSP, in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. The total fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR, therefore can be considered to be insignificant and approaching zero mortality and serious injury rate. Average annual fishery-related mortality and serious injury does not exceed the PBR; therefore, this is not a strategic stock.

REFERENCES

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA, NMFS, NEFSC & SEFSC, 4 pp. Available from NEFSC, Woods Hole Laboratory, Woods Hole, MA.

Archer, F. I., II and W. F. Perrin. 1997. Species account of striped dolphins (*Stenella coeruleoalba*). Paper SC/49/SM27 presented to the IWC Scientific Committee, September 1997. 27 pp.

Baird, R.W., S. K. Hooker, H. Whitehead, and R. Etcheberry. 1997. A Review of records of striped dolphins (*Stenella coeruleoalba*) from Canadian waters. IWC Doc. SC/49/SM4, 10 pp.

Barlow, J., S. L. Swartz, T. C. Eagle, and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Andersen, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 446 pp.

Buckland, S. T., D.R. Andersen, K.P Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling estimating abundance of biological populations. *Oxford University Press*, New York, 432 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Gowans, S. and H. Whitehead. 1995. Distribution and habitat partitioning by small odontocetes in the Gully, a submarine canyon on the Scotian Shelf. *Can. J. Zool*. 73:1599-1608.

Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 *in*: Garner *et al.* (eds). Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES CM* 1997/Q:8. 10 pp.

Lucas, A. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Paper SC/49/06 presented to the IWC Scientific Committee, September 1997. 10 pp.

Mullin, K. D and G. L. Fulling. 2003. Abundance of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. *Fish. Bull., U.S* 101:603-613.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. *Rep. int. Whal. Commn*. Special Issue 16:27-50.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Palka, D.L. 1997. A review of striped dolphins (*Stenella coeruleoalba*) in U.S. Atlantic waters. IWC Doc. SC/49/SM26, 13 pp.

Palka, D. and Hammond, P.S. 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci. 58: 777-787.

Perrin, W. F., C. E. Wilson and F. I. Archer II. 1994. Pages 129-159 *in*: S. H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Volume 5: The first book of dolphins, *Academic Press,* San Diego.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn*. Special Issue 15: 133-147.

Sergeant, D.E., A.W. Mansfield and B. Beck. 1970. Inshore records of cetacea for eastern Canada, 1949-68. *J. Fish. Res. Brd. of Can*. 27: 1903-1915.

Schmidly, D. J. 1981. Marine mammals of the southeastern United States coast and the Gulf of Mexico. Pub. No. FWS/OBS-80/41, U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC, 163 pp.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES* Marine Mammals Comm. CM 1992/N:12, 29 pp.

February 2005

WHITE-BEAKED DOLPHIN (*Lagenorhynchus albirostris*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

White-beaked dolphins are the more northerly of the two species of *Lagenorhynchus* in the northwest Atlantic (Leatherwood et al. 1976). The species is found in waters from southern New England, north to western and southern Greenland and Davis Straits (Leatherwood et al. 1976; CETAP 1982), in the Barents Sea and south to at least Portugal (Reeves et al. 1999). Differences in skull features indicate that there are at least two separate stocks, one in the eastern and one in the western North Atlantic (Mikkelsen and Lund 1994). No genetic analyses have been conducted to distinguish the stock structure.

In waters off the northeastern U.S. coast, white-beaked dolphin sightings have been concentrated in the western Gulf of Maine and around Cape Cod (CETAP 1982). The limited distribution of this species in U.S. waters has been attributed to opportunistic feeding (CETAP 1982). Prior to the 1970's, white-sided dolphins (*L. acutus*) in U.S. waters were found primarily offshore on the continental slope, while white-beaked dolphins were found on the continental shelf. During the 1970's, there was an apparent switch in habitat use between these two species. This shift may have been a result of the increase in sand lance in the continental shelf waters (Katona et al. 1993; Kenney et al. 1996).

More recently, during late March of 2001,one group of 18 animals was seen about 60 nautical miles east of Provicetown, MA during a NEFSC aerial marine mammal survey (NEFSC unpubl data). In addition, during spring 2001 and 2002, white-beaked dolphins stranded on beaches in New York and Massachusetts (see Other Mortality section below).

POPULATION SIZE

The total number of white-beaked dolphins in U.S. and Canadian waters is unknown, although one old abundance estimate is available for part of the known habitat in U.S. waters, and two old estimates are available from Canadian waters (Table 1).

A population size of 573 white-beaked dolphins (CV=0.69) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on spring data because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during this season, according to the CETAP data. This estimate does not include a correction for dive-time or g*(0)*, the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 5,500 white-beaked dolphins was based on an aerial survey off eastern Newfoundland and southeastern Labrador (Table 1; Alling and Whitehead 1987).

A population size of 3,486 white-beaked dolphins (95% confidence interval (CI)=2,001-4,971) was estimated from a ship-based survey of a small segment of the Labrador Shelf in August 1982 (Table 1; Alling and Whitehead 1987). A CV was not given, but assuming a symmetric CI, it would be 0.22.

There are no recent abundance estimates for this species in waters between the Gulf of Maine and the Newfoundland/Labrador region.

Table 1. Summary of abundance estimates for western North Atlantic white-beaked dolphins. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring 1978-82	Cape Hatteras, NC to Nova Scotia	573	0.69
1980's	E. Newfoundland and SE Labrador	5,500	None reported
August 1982	Labrador shelf	3,486	0.22

Minimum Population Estimate

Present data are insufficient to calculate a minimum population estimate in U.S. Exclusive Economic Zone (EEZ) waters.

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow et al. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (Wade and Angliss 1997). The minimum population size of white-beaked dolphins is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic white-beaked dolphin is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

White-beaked dolphins have been taken in cod traps and the Canadian groundfish gillnet fisheries off Newfoundland and Labrador and in the Gulf of St. Lawrence (Alling and Whitehead 1987; Read 1994; Hai et al. 1996); however, the total number of animals taken is not known. Of three bycaught white-beaked dolphins reported off Newfoundland during 1987-1988, 1 died in a groundfish gill net, 1 in a herring gill net, and 1 in a cod trap (Reeves et al. 1999).

There are no documented reports of fishery-related mortality or serious injury to this stock in the U.S. EEZ.

Fishery Information

Because of the absence of observed fishery-related mortality and serious injury to this stock in the U.S. and Canadian waters, no fishery information is provided.

Other Mortality

White-beaked dolphins were hunted for food by residents in Newfoundland and Labrador (Alling and Whitehead 1987). These authors, based on interview data, estimated that 366 white-beaked dolphins were taken each year. The same authors reported that 25-50% of the killed dolphins were lost. Hunting that now occurs in Canadian waters is believed to be opportunistic and in remote regions of Labrador where enforcement of regulations is minimal (Lien et al. 2001).

White-beaked dolphins regularly become caught in ice off the coast of Newfoundland during years of heavy pack ice. A total of 21 ice entrapments involving approximately 350 animals were reported in Newfoundland from 1979 to 1990; known mortality as a result of entrapment was about 55% (Lien et al. 2001).

Mass strandings of white-beaked dolphins are less common than for white-sided dolphins. White-beaked dolphins more commonly strand as individuals or in small groups (Reeves et al. 1999). In Newfoundland, 5 strandings of white-beaked dolphins between 1979 and 1990 involved groups of 2 to 7 animals. On three occasions live dolphins came ashore, including groups of 3 and 4 (Reeves et al. 1999).

White-beaked dolphin stranding records from 1997 to 2003 that are in the US NE Regional Office/NMFS strandings and entanglement database include four records that clearly identify the species to be the white-beaked dolphin. Three of these strandings were collected from Cape Cod, Massachusetts beaches, where 1 animal stranded during May 1997, and 2 animals stranded during March 2001. The fourth white-beaked dolphin stranded in New York in February 2002. It was not possible to determine the cause of death for any of these stranded animals.

Whales and dolphins stranded between 1997 and 2004 on the coast of Nova Scotia as recorded by the Marine Animal Response Society (MARS) and the Nova Scotia Stranding Network are as follows: 1 white-beaked dolphin stranded in May 1997, 0 documented strandings in 1998 to 2001 and 2 in 2002 (1 in July (released alive) and 1 in August).

STATUS OF STOCK

The status of white-beaked dolphins, relative to OSP, in U.S. Atlantic coast waters is unknown. They are not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population trends for this species. Because there are insufficient data to calculate PBR it is not possible to determine if stock is strategic and if the total fishery-related mortality and serious injury for this stock is significant and approaching zero mortality and serious injury rate. However, because this stock has a marginal occurrence in U.S. waters and there are no documented takes in U.S. waters, this stock has been designated as not strategic.

REFERENCES

Alling, A. K. and H. P. Whitehead. 1987. A preliminary study of the status of white-beaked dolphins, *Lagenorhynchus albirostris*, and other small cetaceans off the coast of Labrador. *Can. Fld. Nat.* 101(2): 131-135.

Barlow, J., S. L. Swartz, T. C. Eagle and P. R. Wade. 1995. U.S. Marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S.Dept. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Hai, D.J., J. Lien, D. Nelson and K. Curren. 1996. A contribution to the biology of the white-sided dolphin, *Lagenorhnchus albirostris*, in waters off Newfoundland. *Can. Fld. Nat.* 110(1): 278-287.

Katona, S. K., V. Rough and D. T. Richardson. 1993. *A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland.* Washington, D. C. Smithsonian Institution Press. 316 pp.

Kenney, R. D., P. M. Payne, D. W. Heineman and H. E. Winn. 1996. Shifts in Northeast shelf cetacean distributions relative to trends in Gulf of Maine/Georges Bank finfish abundance. Pp. 169-196. *In:* K. Sherman, N.A. Jaworski and T. Smada (eds.) *The Northeast Shelf Ecosystem: Assessment, Sustainability, and Management.* Blackwell Science, Cambridge, MA 02142, USA.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lien, J., D. Nelson and D.J. Hai. 2001. Status of the White-beaked Dolphin, *Lagenorhynchus albirostris*, in Canada. *Can. Fld. Nat.* 115(1): 118-126.

Mikkelsen, A.M.H. and A. Lund. 1994. Intraspecific variation in the dolphins *Lagenorhnchus albirostris* and *L. acutus* (Mammalia: Cetacea) in metrical and non-metrical skull characters, with remarks on occurrence. *J. Zool.*, Lond. 234:289-299.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn.* Special Issue 15: 133-147.

Reeves, R.R., C. Smeenk, C. C. Kinze, R. L. Brownell Jr. and J. Lien. 1999. White-beaked dolphin (*Lagenorhnchus albirostris* (Gray 1846). Pp. 1-30. *In*: S.H. Ridgway and R. Harrison (eds.) *Handbook of marine mammals, Vol 6.* Academic Press, San Diego, CA.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12,

93 pp.